THE ENGINEER

A Seven-Day Journal

Harwell

THERE was published last week by H.M. Stationery Office a book entitled *Harwell*, which presents the first connected story of the work and problems of the Atomic Energy Research Establishment, Harwell, from its inception in 1946. After giving a brief account of the events leading to the formation of the Atomic Energy Research Establishment in 1946, and a review of its organisation, there is an outline of the main tasks on which Harwell is working. These are treated under four heads: the production programme, isotopes, nuclear reactors, and particle accelerators. One main programme covered is the production and use of radio-isotopes, and a new use in the medical field is shown in an illustration of a skin graft operation. It is shown that there are many factors in the design of reactors, and whether fission is to be caused by fast or slow neutrons, or neutrons of intermediate velocity. Three types of reactor have been chosen, and from recent statements by Sir John Cockcroft, it is clear that a building programme is under consideration. The use of new materials, such as beryllium and zirconium, of liquid metal coolants for achieving very high heat-transfer rates, and the effects of very intense nuclear radiation on materials are mentioned. Two things not widely known emerge in this account and show the way in which the British lead in synchrotron and linear accelerator design, following their wartime radar experience, and the use of these accelerators in radiotherapy. Some of the fundamental research at Harwell in the fields of physics, chemistry and metallurgy is also described. Much of the pure research in chemistry has naturally been directed towards the study of the heavy elements and, beyond them in the periodic table, the artificially created transuranic elements, and the book describes various investigations which have taken place, particularly into the electron configurations of the transuranic elements. In analytical chemistry, very sensitive techniques for the detection of trace elements have been developed, and many of the researches in metallurgy which are of fundamental interest are described. A final chapter describes Harwell's extra-mural relations.

The Association of Consulting Engineers

ON Wednesday, May 28th, the Association of Consulting Engineers held its annual general meeting, and in the evening its annual dinner, at the Waldorf Hotel. At the dinner, the toast of "The Association" was proposed by Mr. A. S. Quartermaine, president of the Institution of Civil Engineers, and replied to by Mr. J. Duvivier, chairman of the Association. During the course of his remarks Mr. Quartermaine spoke of the effects of the increase during the past ten years of nationalised and public bodies on the consultant's work. He also commented on the question of contract arrangements, with particular reference to work abroad. In some countries it was the practice for a consultant, a contractor, a manufacturer, and perhaps a finance house, to make the entire arrangements for a project. Whether or not this method had any advantage, Mr. Quartermaine thought, might well be the subject of a talk between the Institution, the Association, and the Federation of Civil Engineering Contractors, so that some facts might be obtained. Mr. Duvivier spoke of the same problem, his views being similar to those held by Mr. Quartermaine; he also spoke of the question of publicity. Mr. Duvivier emphasised that the strict code of ethics of consultants, which placed the interest of the client above all consideration of personal gain, had been largely responsible for giving the profession its present status, and would not be abandoned lightly. However, the Association was alive to modern trends, and it would not be surprising if a new approach might shortly be found. These two questions of publicity and rules of procedure concerning works abroad were also commented upon by Sir Bruce White, who proposed the toast of "The Guests." This toast was replied to by Sir Leslie Rowan, the second secretary of the Treasury.

Road Policy

ON May 29th the Minister of Transport, Mr. Lennox-Boyd, received a deputation from the British Road Federation and a memorandum on road policy, which had been prepared by the Federation, was discussed. The Federation pointed out in this memorandum that in 1946 a ten-year highway development plan was prepared by the Ministry of Transport, but practically no work has been done on it. Furthermore, the essential requirements of defence, accident prevention, productivity, with particular reference to exports, and the cost of living required a programme of road work to be initiated. The memorandum gives evidence to support this view, and maintains that expenditure on road work under the prevailing economic conditions can be amply justified. Amongst other evidence, the presidential address to the Institute of Transport, given last October, of Mr. A. B. B. Valentine, is quoted, in which he expressed the opinion that an expenditure of, say, £10 million on road improvement would produce a bigger and quicker dividend in the saving of man-hours, equipment and resources than an equal expenditure by almost any of the major industrial users of capital to-day; an investment on roads could be shown, it had been said, to yield a return in increased material productivity perhaps three times greater than the return for the same capital spent on oil, or steel or even on electricity, and about the same return for similar expenditure on coal mining. The arguments put forward in the memorandum include notes on the effect of uncompleted major road schemes, and of weak and low bridges on trunk roads. An analysis of the cost of an inadequate road is given and it is pointed out that the annual economic loss to the country of accidents is estimated at £146 million.

Steel Supplies and the Motor-Car Industry

IN the course of a debate on the future of the motor-car industry, in the House of Commons last week, the Parliamentary Secretary to the Ministry of Supply said that within the limited supplies at present available it was the Government's intention that those firms which increased their exports should receive a higher allocation of steel. He pointed out that the number of cars exported by particular firms and the success which firms had had in exporting to hard currency countries had long been factors taken into account in making steel allocations. In 1950 the motor industry exported 550,000 vehicles, of which 400,000 were motor-cars, and in 1951 of the 510,000 vehicles exported, 360,000 were motor-cars. In the first four months of this year the industry produced just under 150,000 motor-cars and 76,000 commercial vehicles, and 127,000 cars and 49,000 commercial vehicles were exported during that period. There had been much speculation as to what would be the effect on the total export of motor-cars and commercial vehicles of the action taken by the Australian and some other Governments in restricting the quantity imported from this country. It was as yet too early to say whether the motor industry would or would not be able to find substitute markets elsewhere in the world. In the past two years between 110,000 and 120,000 motor-cars and about 100,000 commercial vehicles had been supplied each year to the home market. The quota given to the industry for supplies to the home market last year was 80,000 each of cars and commercial vehicles, plus half of any produced in excess of 460,000 cars and 230,000 vehicles. This came to a quota of 88,000 cars and 94,000 commercial vehicles. The quotas set in January this year were 60,000 each of cars and commercial vehicles.

Fencing of Hydraulic Presses

METHODS for safeguarding heavy hydraulic presses are dealt with in a recent report of the Joint Standing Committee on Safety in the Use of Power Presses, which has been submitted to the Chief Inspector of Factories. The report points out that the increasing use of hydraulic presses in the sheet metal and other industries and the considerable development in their size and working speeds necessitated the setting up of a sub-committee of experts to consider ways of safeguarding operatives against risk of trapping at the tools of these machines. The report of this sub-committee, which has been adopted by the Joint Standing Committee with few amendments, proposes two forms of guard as appropriate—the sliding screen guard and the photo-electric safety device. It is considered that sliding screen guards effectively controlling the electrical equipment afford an effective physical protection and that there is an appropriate field for a safety device operating on the photo-electric principle. The report also contains recommendations to be observed in connection with the electrical equipment of hydraulic presses and it stresses the need for effective inspection and maintenance of the safety device and those parts of the machines which affect safe working.

Loans for Fuel Saving Devices

IN a statement to the House of Commons last week, the Minister of Fuel and Power gave details of the Government experimental loan scheme designed to encourage the installation of industrial fuel saving equipment. The scheme will apply in approved cases to industrial firms able to save substantial amounts of fuel by installing any of a number of specified fuel saving devices. The total amount which will be available for loans will not exceed £1,000,000 and no firm will receive a loan exceeding £25,000. Commercial rates of interest will be charged for the loans. An explanatory leaflet giving full details of the scheme and an application form can be obtained from the Fuel Efficiency Branch, Ministry of Fuel and Power, Queen Anne's Chambers, Dean Farrar Street, London, S.W.1. It is pointed out in this leaflet that since the capital available for the loans is limited and the scheme will be in operation as an experiment for one year only, loans will be made available only for work completed in a reasonable time and in any case not later than five years from the commencement of the scheme. They will be made on structural insulation of existing factory buildings and specified items of equipment which when introduced as part of existing plant will automatically save substantial quantities of fuel. The specified fuel saving devices are back pressure engines and turbines, feed water economisers, air preheaters, heat exchangers, and waste heat boilers, as well as structural insulation of existing single-sheeted factory walls and roofs.

Harvesting of Brown Sub-Littoral Seaweeds

No. I—ASSESSMENT OF THE PROBLEM AND REVIEW OF PRELIMINARY EXPERIMENTS

By PHILIP JACKSON, M.Sc., M.I.Mech.E., M.I.Chem.E., F.R.S.E.*

(*Concluded from page 720, May 30th*)

Machinery is being devised for the commercial harvesting of British sublittoral seaweeds. Two main principles are being investigated, namely, tearing the weed from the sea bed and raising it to the surface mechanically, and cutting the weed from the sea bed and raising it by entrainment in water. In this, the first of a series of articles, the problem is reviewed and particulars given of exploratory experiments.

The Cutting and Entrainment Principle

THE application of this principle to the continuous harvesting of sublittoral seaweed was first tried during the 1939–45 war when alginic acid was required for the manufacture of camouflage materials. The results of this attempt have been fully described by Mackenzie in a previous article[12]; it is intended in this article only to discuss these results in relation to further development and to put forward possible means of overcoming the faults revealed.

Continuity of harvesting during the wartime trials was seriously interrupted by frequent breakdown of mechanical gear, by weed draping over the cutting head and "blinding" the cutters, by jamming of the cutters and by the entrainment of stones adhering to the weed. Because of the position of the cutters relative to the sea bed the machine was only suitable for the harvesting of frond.

The maximum harvesting rate, achieved on one run only, was about 4 tons per hour, the average rate over 116 runs being considerably lower at about 0·5 tons per hour. Since the effective cutting width was 3ft, and the velocity of the cutting head relative to the sea bed about 1·8ft per second, the average weight of weed cut per square yard was only about 0·5 lb. The average density of growth in the test area has been shown to be about 6 lb per square yard,[1] so that the harvesting efficiency was only about 8 per cent, which is far too low for economic harvesting.

The principal problems of (i) cutting the weed from the sea bed, and (ii) raising it to the surface, were not investigated separately, and the results could therefore only be attributed to the unit as a whole. Before resuming the development of this principal of harvesting it is therefore necessary to give some thought to a closer definition of the problems involved, and the most promising lines to follow in their investigation. With this object in view a developmental research programme has been arranged on the basis of the discussions which follow.

Cutting Seaweed from the Sea Bed

The essential requirements in a seaweed cutter are (i) ability to cut the stipe of the weed about 6in above the sea bed at various angles of presentation, dictated by the pitching and rolling of the supporting structure, (ii) effective protection against damage by projecting rocks, (iii) prevention of weed draping and jamming the mechanism, and (iv) mechanical reliability.

The rotating knife type of cutter used in the first design has two serious disadvantages —(i) its intermittent cutting action, involving a high momentary torque, appears to encourage the clumping of weed and consequent jamming of the blades, and (ii) its comparatively high speed of rotation makes it very susceptible to damage. Apart from these disadvantages the driving power required might, in itself, preclude the economic use of this type of cutter—in the original cutting head the position of the cutters limited cutting to the frond only which, in turn, limited the maximum theoretical capacity to not more than 50 per cent of the available weight of weed; the actual capacity was considerably lower than the theoretical maximum, possibly due to the deflection of weed away from the cutters by the flow of water past the cutting head, but difficulty was experienced in cutting and the power supplied was no more than adequate. For maximum efficiency it is necessary to harvest both the frond and stipe of the weed, and since stipe, because of its thickness and texture, is more difficult to cut, the load on the cutters will be appreciably increased.

These drawbacks might, to some extent, be overcome by redesign after an analysis of the factors involved, but it is obvious that some consideration should be given to other possible means of cutting such as (i) moving knives of the reciprocating type similar in form and operation to those used in agricultural mowers, binders and combine harvesters; (ii) toothed discs operating in contact with finger plates or counter-rotating discs; (iii) band saws running over shrouded pulleys placed at the four corners of the rectangular entrance to the cutting head; (iv) reciprocating saws placed at the bottom leading edge of the cutting head and possibly at the vertical sides; (v) revolving high-tensile steel wires stretched horizontally between two synchronised rotating discs, or (vi) a modified propeller pump carrying cutting blades in a vertical plane.

It has been shown that fixed cutters, i.e., cutters relying on the forward motion of the cutting head for their cutting action, although possessing the advantages of simplicity, ease of replacement and low initial cost, are quickly rendered ineffective by weed draping and clogging. This is particularly true at speeds of tow considered to be safe for damage-free operation on the sea bed.

Cutters used in agricultural machinery—(i) above—usually have a low operating speed, a limited movement and a very robust form, all of which are very desirable characteristics in equipment for operation on the sea bed. A modified form of reaper cutter is, in fact, used in the harvesting of seaweeds of the *Macrocystis* and *Nereocystis* types off the Pacific Coast of America,[13] species which present a much simpler harvesting problem generally, but which tend to drape and jam the harvesting mechanism every bit as badly as those found in Scottish waters.

Toothed discs are a definite improvement over rotating knives because of their lower effective operating speed and more evenly distributed loading.

A band saw cutter, by virtue of its moving upper horizontal and vertical parts, is an ideal anti-draping cutter, although its protection against damage by rocks may present some difficulty. Also, its practical application is limited by the reduced angle of embrace and the severe strains introduced to the band when operating over small pulleys.

An arrangement embodying revolving wires between synchronised rotating discs with their common axis above and parallel to the leading edge of the cutting head has the advantage that less protection is required in the way of intermediate skids as there is no delicate cutting edge that might be damaged. The tendency for weed to drape over the cutting head, a serious difficulty in most systems, is thus considerably reduced. Another advantage of this system is that broken wires are quickly and easily replaced.

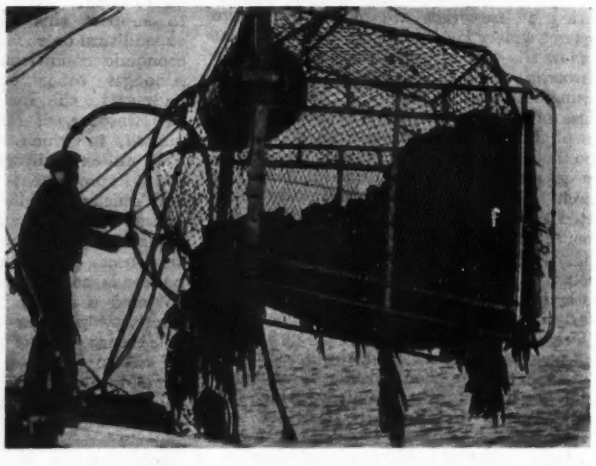

FIG. 5—EXPERIMENTAL TRAWL FOR TESTING CUTTING MECHANISMS

A modified propeller pump carrying cutting blades has little to recommend it from the cutting angle; the only reason for its inclusion is the possibility of adapting it to assist in guiding the cut weed to the entrainment system inlet, a problem which will be discussed later.

While it is conceivable that the troubles occasioned by weed jamming the cutters could be reduced, if not eliminated, by careful attention to the form of cutting head and by ensuring that the cut weed is promptly and permanently removed from the vicinity of the cutters, a more difficult problem is presented by the "blinding" effect of weed draping on the projecting parts of the cutting head. Because of the overhanging form of many of the obstructions encountered on the sea bed, protection must be provided in front of the cutters, and it is here that draping and consequent "blinding" are so liable to occur. It is possible that the problem can

* Deputy director, Institute of Seaweed Research, Invereak, Midlothian.

be solved by a proper arrangement of cutter protecting skids, but a considerable amount of experimentation on the sea bed will be necessary before the most effective arrangement can be found. The most effective form of support for the cutting head and the behaviour of cut weed under the influence of different cutting conditions should be investigated at the same time. Fig. 5 shows an experimental trawl for testing cutting mechanisms for sublittoral seaweed harvesters. The cutters are mounted at the lower leading edge and a buoyancy drum at the upper leading edge. The tapered construction is adopted to counteract a tendency to plane upwards at speed, due to water pressure.

Entrainment

If during the trials the 6in water pump was operating at its rated capacity of 1100 g.p.m., the percentage of weed in the weed-water mixture at the average harvesting rate of 0·5 tons per hour would be only 0·77. The entrainment of solids of small dimensions in water is a proved method of material handling, the only difficulty being in the feed and intake of the solids to the system. That this was so in the original harvester is supported by an examination of the feed mechanism. The only inducement to the weed to enter the system was provided by the velocity of flow through the suction ports. The influence of this flow in the surrounding water is very small unless the velocity is unusually high and during the trials it was never greater than 4·2ft per second, and more often only about 1·5ft per second. This limited influence was further reduced by the flow of water relative to the forward movement of the cutting head. In these circumstances it is impossible that much weed could be attracted to the suction intake and it seems fairly certain that this was one of the principal causes of the low harvesting efficiency.

It is doubtful if decreasing the port area would effect any significant improvement and, in any case, in developing the method to harvest whole plants an even greater area will be required; nor would it be practicable to increase the velocity of flow through the ports to a magnitude at which it would be effective in this respect. Mackenzie[12] claims that with a velocity of 4·2ft per second troubles were experienced due to the entrainment of stones adhering to the weed and that these troubles were largely eliminated by reducing the velocity to 1·5ft per second; it is, however, difficult to see how a velocity of 4·2ft per second could have been responsible for lifting stones from the sea bed and the point is one that will require further investigation.

The solution of this problem appears to lie in devising some means of guiding the cut weed to a point where it comes under the influence of a reasonable intake velocity, utilising, as far as possible, the natural flow of water relative to the cutting head and possibly assisted by high-pressure water jets or moving screens.

The desirability of harvesting whole plants, free from damage, introduces new problems to the design of an entrainment system, the first of which is the choice of a suitable pump. The centrifugal pump used in the first unit was found to be generally satisfactory for the pumping of frond in small pieces, but the tests gave no indication of its behaviour when pumping stipe or whole plants. While there is no reason to doubt its suitability for pumping small pieces of stipe, it is unlikely that whole plants could be pumped without fairly extensive damage being inflicted on the cell walls. Preliminary tests carried out at the works of Drysdale and Co., Ltd., Glasgow, on a cast iron centrifugal pump of the volute type fitted with a two-passage, full-area unchokeable impeller have, in fact, confirmed that this is so.

The ideal system is one free from moving parts on which the weed might drape and cause blockage or suffer damage. This suggests the use of pumps operating on the high-velocity water jet or air-lift principles, with the activating pump or the air compressor situated on the deck of the harvesting boat.

The conventional water jet pump, with its centre nozzle, is unsuitable because the nozzle itself forms an obstacle to the entrance of weed to the system. This disadvantage has been overcome in a new kind of jet pump (Fig. 6) by replacing the centre nozzle with a circumferential slot giving a cylindrical jet of activating water and a clear passage through the body of the pump. Tests have already indicated that this special design of pump is technically suitable for the pumping of whole seaweed plants without choking. Its main disadvantage is its low efficiency due to the high shock loss at mixing of the activating and induced waters and, to a lesser extent, losses due to wall friction.

Body constructed in two parts to permit variation in nozzle area by the insertion of the packing plates shown in the foreground.

FIG. 6—WATER JET PUMP

From preliminary investigations of the use of the air-lift pump it appears that the effectiveness of this type of pump falls off rapidly as the angle of the delivery pipe to the vertical exceeds about 30 deg. To operate a harvester with the delivery pipe at angles of this magnitude or less would necessitate a somewhat complex mechanism to give flexibility between the surface and under-water equipments adequate to compensate for the very irregular nature of the sea bed. Also, whereas it appears that the high-velocity water jet pump can be placed anywhere in the system and still operate effectively, the air jets are limited in their positioning to the foot of the suction pipe. For these reasons it appears unlikely that the air-lift principle will be as suitable as the high-velocity water jet, although further consideration should be given to this method of pumping when circumstances permit.

It is obviously not practicable to pump through the entrainment system all the water which enters the front of the cutting head, the construction of which must therefore allow the escape of surplus water through the sides of the lead-in portion. This introduces a difficulty if the movement of weed towards the cutters is controlled solely by the flow of water through the lead-in, as it was in the original cutting head, in that the outflow of water through the sides tends to force the weed against the grids and cause blockage. The proposed arrangement incorporating moving screens or high-velocity water jets should, however, effectively counteract this tendency.

Future Development

Before the practical difficulties outlined above can be overcome and an effective harvester operating on the cutting and entrainment principle designed, it will be necessary to carry out more comprehensive and separate investigations of the problems involved, and of the various devices suggested on the basis of our present knowledge. After sufficient data has been obtained in this manner the next step will be to design and construct a prototype unit for operation from the smallest practicable size of boat, with the object of proving the principle of operation over a considerable number of runs on different sea beds. From the experience so gained it should be possible to proceed with the design and construction of a commercial scale harvester for final tests to study the economics of harvesting by this method.

Conclusions

It would be unwise, nor would it be possible at this stage, to forecast the results of the more comprehensive investigations which must be carried out, but although many problems remain to be solved, the preliminary investigations aimed at assessing the technical feasibility of both principles of harvesting have given very encouraging results.

The economics of seaweed harvesting will depend, to some extent, on the location of the processing factories in relation to the harvesting site, the use of efficient drying and grinding plant, or finding economic means of preservation to permit wet weed storage if wet processing is used, the utilisation of both frond and stipe, and the commercial exploitation of mannitol, laminarin and fucoidin, in addition to alginic acid.

A knowledge of local coastal conditions is essential, and for this reason the employment of local crofters and fishermen in boat crews will be strongly recommended.

Acknowledgments

The work described in this paper forms part of the programme of research and development undertaken by the Institute of Seaweed Research, to whom the author is indebted for permission to publish.

The experimental work on the intermittent grapnel was carried out by Mr. William Mackenzie.

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Ottmarsheim Canal and Power Station on the River Rhine

No. I

Construction of the Alsace Canal, to improve navigation on the Rhine and to utilise its flow for the generation of power, from the Swiss frontier to Strasburg, was approved in 1925. *Eight stages of construction were envisaged, each involving a length of canal, locks and a power station. The first stage only was built before the war, but the second stage has now been substantially completed and is described herewith. It involves a large canal,* 14km *long, two locks and a power station. The head is* 16·4m, *and the power station will generate some* 1000 *million kWh annually from four* 35 *MW turbo-alternator sets.*

FROM time to time we have noted in these columns various schemes which have been proposed or constructed to harness the waters of the major Continental rivers such as the Danube, the Rhine and the Rhone, for navigation or for the generation of electrical power. The more ambitious of such schemes may be discussed for many years, as have the proposed navigable links between the Rhine and the Danube, and the Rhine and the Rhone. Present-day conditions, however, in spite of their many drawbacks, seem to be favourable for the execution of such works, at least where the generation of a substantial amount of electrical power is concerned. A fine example is that of the works of the Compagnie Nationale du Rhone, which were described in our issues of December 8 to 29, 1950. Another example, with which this article is concerned, is that of the projected Grand Canal of Alsace, on the Upper Rhine. The idea of this proposal was to build a canal beside the Rhine from a point near Basle, close to the Swiss frontier, to Strasburg, thus utilising a total head of 106m, and making the Rhine navigable over this length at all times.

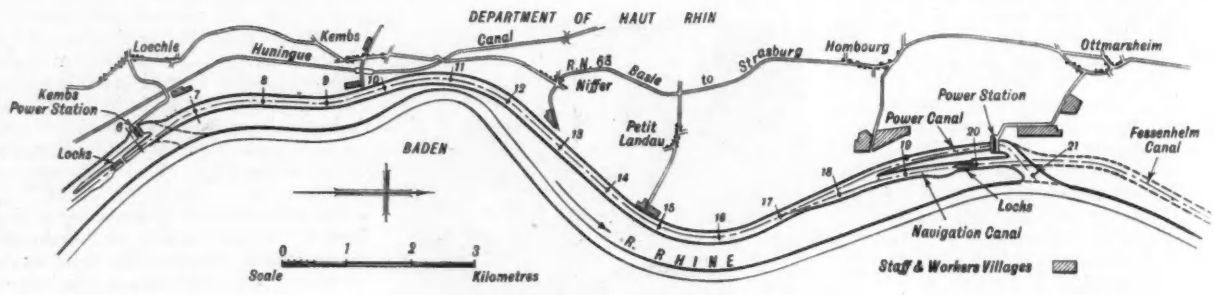
The canal was first proposed in 1893, and was officially adopted in 1925. A total length of 112km of canal was envisaged, on the left bank of the Rhine, with eight power stations, each associated with two locks, and producing a total of 5700 million kWh annually. The first stage of the scheme, involving the length of the canal nearest Basle, with an intake barrage across the Rhine at the upstream end, and the Kembs power station and locks at the downstream end, was completed in 1932.

In the description of the Kembs power station given in our issue of August 26, 1932, it was stated: "Whether the entire scheme will be carried through depends on circumstances, for parliamentary sanction will be required for the construction of the remaining seven sections, and in view of changes that have taken place in the situation generally, there may be less urgent need than formerly to push forward with the canal to Strasburg. The utility of the Kembs section is unquestioned, for it removes the most serious difficulty to Rhine navigation by enabling barges to avoid the Istein bar. This bar is a mass of rock over which the depth of water is being steadily reduced by the deepening of the river bed above it, which is thereby forming rapids which the barges can negotiate only with extreme difficulty at certain times of the year."

In fact, the second section of the Alsace canal—the canal, locks and power station of Ottmarsheim—was not started until after the war. After the completion of the Kembs power station some difficulty was experienced in consuming the energy generated, so there was little encouragement for further construction prior to 1939. The second section is now approaching completion, however, and a start on the third section, the Fessenheim project, is due to be made this year. As was to be expected, a number of modifications of the original design of the Ottmarsheim scheme were incorporated when it was finally built; in particular, the dimensions of the locks and the lay-byes left just above and below them, were obtained largely as a result of experience with the Kembs locks. Before describing the Ottmarsheim development, however, some brief remarks on the Kembs canal and power station are included in the next two paragraphs.

The power station at Kembs contains six Kaplan turbo-alternator sets, each of 31MVA capacity, utilising a head of 16·6m and producing about 800 million kWh annually. There are two locks, with lengths of 185m and 100m and widths of 25m. The canal is 6km long and divides into two parts upstream of the power station and locks, with one branch for navigation and one for power. Downstream of the power station a short canal leads back into the River Rhine. The Ottmarsheim canal leads from this canal, a berm having been left between the two during construction. On completion of the Ottmarsheim section, the berm will be removed, and a berm built between the river and the junction of the two canals. This work is shown in progress in the illustrations below, showing Kembs power station and the upstream part of Ottmarsheim canal.

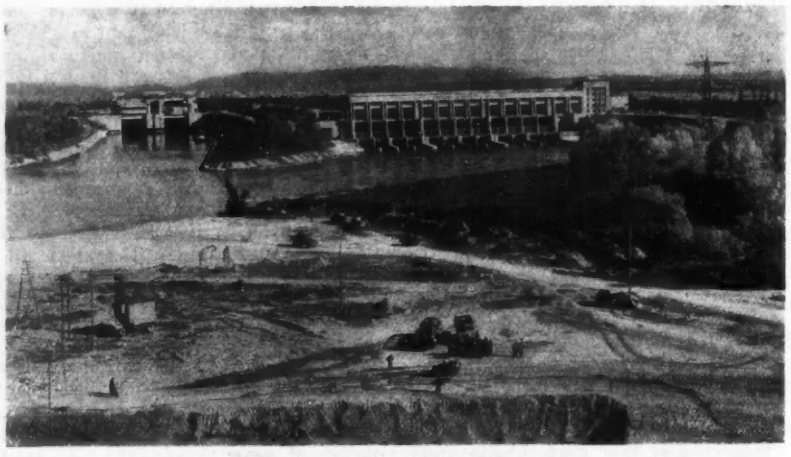
During the war the Kembs power station and the intake dam further upstream, were both severely damaged, the intake dam by the R.A.F. These installations were repaired immediately after the war, turbo-alternator sets of the original size and capacity being installed at Kembs, as the original substructures were relatively undamaged.



THE OTTMARSHEIM CANAL

The Ottmarsheim Development

Hydro-electric construction in France has been very active since the war, and the project of Ottmarsheim is one of the more extensive of the many schemes which have been undertaken. It is not as large as the Donzere-Mondragon scheme, which was described in our article on the River Rhone mentioned earlier, although it has some points in common with that scheme. It consists of a canal 14km long, leading from Kembs power station, along the left bank of the Rhine to the power station and locks, as may be seen from the accompanying plan.

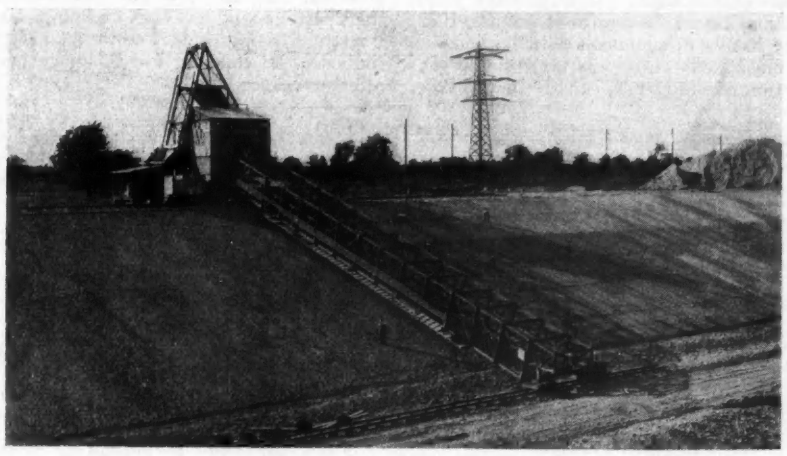


KEMBS POWER STATION AND LOCKS

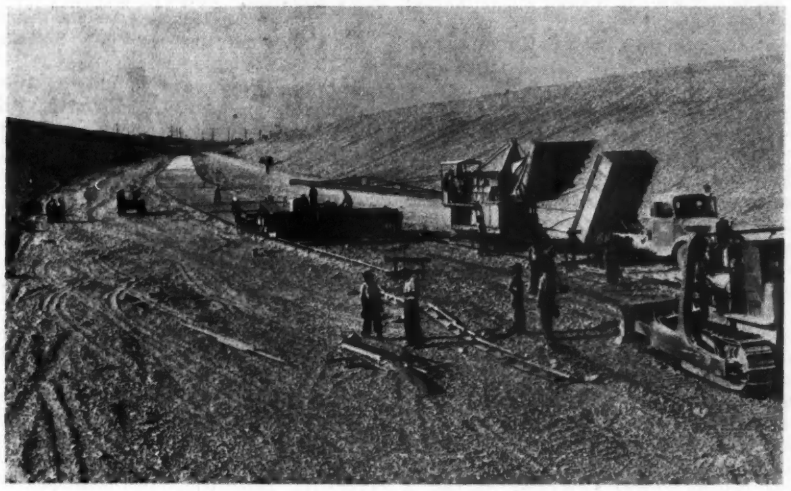
There are two locks, their dimensions being 185m by 23m and 185m by 12m respectively. The power station will have four 35MW Kaplan turbo-alternator sets installed in it, with a head of 16·4m. The mean annual production of power will be 1000 million units. The site is a favourable one from the hydro-electric point of view; it is easily accessible and the main works were able to be carried out in the dry. The construction of the canal, however, apart from its magnitude, has been a task involving several interesting points.

Excavation was carried out by an extensive array of earth-moving plant, three walking draglines of large capacity playing an important part in the work. Each of these machines had a bucket of 8 cubic metres capacity, and a reach of 50m. The tail race canal was excavated by a chain bucket excavator, with 750 litre buckets, which had been used in excavating the Kembs canal. The total volume of excavation involved was about 18½ million cubic metres; in 1949 alone some 5,600,000 cubic metres of excavation was completed at Ottmarsheim, out of a total of 6,761,000 cubic metres on all the projects which Electricite de France had in progress at that time. Apart from excavation, a total of 650,000 cubic metres of concrete has been needed for the completion of the project, including 23,000 5-ton precast slabs.

The canal has a bottom width of 80m, with side slopes of 3 : 1, the depth of water being 9 or 10m. Its bottom level drops from 224m above sea level at the tail race of Kembs, to 221·37m at the 8km point (the figures on the plan show the distances in kilometres from the Kembs canal intake) and the fall is then 0·07m per kilometre to 220·63 at the locks. The normal water level is 230. Where the canal divides close to the power station, the navigation branch has a bottom width of 69m, 3 : 1 side slopes and the same depth as before; the power canal has a bottom width of 40m, side slopes of 2·5 : 1, and a depth of 13m. Immediately downstream of the locks the navigation canal is 100m wide (it is also wider immediately upstream of the locks), and where it is joined by the power station tail race the width is 168m, for the short length leading back into the River Rhine. Eventually the intake of the Fessenheim canal will be built at this point to continue the development downstream. About halfway down the canal its right bank has been left lower than the level obtaining elsewhere, thus providing a spillway back into the river. Should the lock gates at Kembs fail, the resulting wave would spill over the bank at this point, and thus not reach the power station.



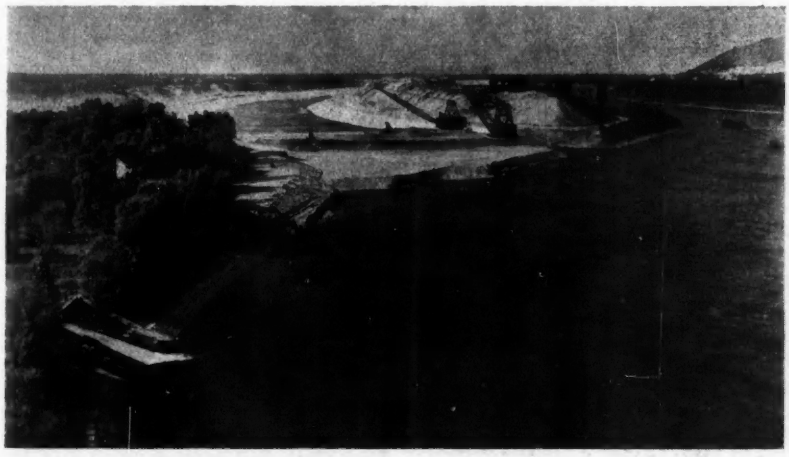
CONCRETING MACHINE FOR CANAL BANK



CONCRETING THE CANAL BOTTOM

One of the problems of the design of the canal was to prevent losses by seepage. Various methods of lining were therefore employed in different lengths of the canal, depending, for instance, upon whether the side slopes were excavated below the natural ground level, or were formed by berms of excavated material. At its upstream end the natural surface excavated to formation level was considered sufficient for the canal bottom; lower down it was consolidated, and lower down still, after consolidation, a thin layer of mineral clay (bentonite) was spread over it by machine, followed by a layer of fill, which was also consolidated. Still further downstream a concrete bottom was placed. This work is shown in progress in the illustration above, where, it may be observed, plant normally employed in airfield or road construction was utilised. A layer of gravel, 1m thick, was placed over the concrete on completion of the work, so that barges will be able to anchor on the bottom without causing any damage.

The side slopes have been lined with concrete. At the upstream part the lining extends only just above and below the normal water level; further downstream it extends over the entire side slope (mean thickness 13cms), with a better quality concrete at the water level, and in the downstream part of the canal it consists of precast slabs, made by the vacuum concrete process. The in-situ lining was not reinforced and was placed by the machine shown in the illustration above. The whole machine moved along the bank on rails and contained a concrete mixer. A skip travelled along the boom to emplace the concrete. The capacity of this machine was, in practice, about ten cubic metres per hour. Aggregates were supplied to the mixer from lorries, each carrying four measured batches in separate compartments. The machine was preceded by a similar machine, whose function was to screed the



UPSTREAM SECTION OF THE OTTMARSHEIM CANAL

surface of the bank. It is perhaps worth recalling that in our article of August, 1932, on the Kembs development a similar machine was illustrated, which was used in the construction of the Kembs canal. In this case, however, the one machine performed all the operations of levelling, tamping, laying wire mesh reinforcement and emplacing the concrete. Its capacity was 25 square metres of concrete per hour.

(To be continued)

Suction Gas Plant Development Fifty Years Ago

By W. A. TOOKEY, M.I.Mech.E.

HALF a century has now gone by since the internal combustion engineers of that day were enthralled with the future possibilities that seemed destined to determine the suction gas producer as "the" power of the future.

Most of the gas engine manufacturers were then busily engaged in improving upon the earlier efforts of Benier (France), who had demonstrated that by coupling an engine to a furnace of charcoal and similar fuel, it was possible to obtain sufficient gas to keep the engine going. Inadequate patent protection threw open to other enterprising engineers this unique opportunity of getting "something for nothing."

Dowson's pressure gas producer using bituminous coal with its bulky and costly apparatus for ensuring tar free gas had been utilised for about twenty years before 1900, and had certainly done much to develop "the large gas engine" as then known; but the introduction of the suction gas plant using coke or anthracite, requiring the minimum of scrubbing apparatus, with no need for pressure fans or gas holders, with actuation of the draft through the furnace by the engine's own induction pipe seemed almost to be a gift from the gods.

In 1902 therefore, every internal combustion engineer was agog and competing designs were being put on the market in increasing numbers, and naturally interest in future development was universal here and on the Continent of Europe. The new "suction" gas apparatus was not only envisaged for factory power plant but the British Admiralty was interested in the Marquis of Graham's (now the Duke of Montrose) experimental adaptation for marine service. On the Continent several attempts were similarly being made to adapt barges for canal and river transport for suction gas propulsion without encroaching too much on cargo space.

Probably the period of most active development occurred between 1902 and 1906, for in the latter year the Royal Agricultural Society had arranged a series of competitive trials during its annual summer show at Derby and the report on those trials by independent engineers was, therefore, of considerable interest. The present writer had in 1904 terminated his fifteen years' service with Tangyes Ltd., and was therefore cognisant of the developments made in gas and oil engines since 1890. He had started on his own account as a consultant in 1905; had published hand-books for Percival Marshall and Co. on gas engines and allied subjects, and in 1906 was responsible as editor of *The Gas and Oil Engine Record*—a monthly journal which was amalgamated later (1908) with *The Power Engineer*, edited by Percival Marshall. It was the author's personal duty, therefore, to attend the Derby trials and note the relative performances of each competing installation. The official report placed the "National" in the forefront and it was probably due to this that the late H. N. Bickerton, its Chairman, then in his hey-day of accomplishment, said that in his opinion the suction gas producer was destined to beat all competing forms of motive power. Bickerton if still alive, would be interested in knowing that an installation originally set to work under the writer's supervision at a wood working factory at Chiswick, in 1908, though reconditioned under insurance inspection from time to time, is still, in 1952, giving reliable service.

In those early days supplies of suitable anthracite were plentiful and cheap. Advertisers claimed 18 b.h.p. output for one penny per hour for suction gas plant users and many electrical firms did good business in equipping country mansions with electric lighting throughout the provinces. In a word, the boom was "on." The oil engine of that period, still of the vaporising or lamp oil type, with low compression, was therefore being displaced due to its low efficiency, unreliability and obnoxious, sooty deposits requiring frequent cleaning and involving higher maintenance costs.

It was in 1904 that the diesel engine was really put forward by Dr. Ade Clark's paper read before the Institution of Mechanical Engineers. This paper gave instances of industrial application, meriting such attention that it encouraged engine makers to devote time and money to further improvement of the paraffin engine.

Meanwhile, progress continued with the application to industrial processes of suction gas apparatus though not always successfully; due in most cases to lack of adequate furnace area and of fuel capacity to provide for the heavy demands of the engines which they were required to serve. This was particularly noticeable when, after 1906 engine speeds were on the increase and the Derby trials had introduced multi-cylinder vertical gas engines running at 600 r.p.m., as compared with the old timers of the horizontal type running well under one-third of that figure and usually governed by hit-and-miss devices, and not by quantity of mixture regulation with a constant rate of impulses per unit of time.

Experiences at that stage of development were of considerable technical interest, involving considerations that were often outside current text book data and therefore demanding concentration upon new problems before elucidation was possible. Complications occasionally resulted from the conglomeration of units purchased from diverse sources and where contract obligations were undertaken recklessly. One such instance occurred when to obtain an order against strenuous competition the representative of a well-known suction gas apparatus manufacturer undertook to utilise the CO_2 from gas engine exhausts for an industrial process and thus avoid the necessity of obtaining CO_2 from a separate source. On paper this project appeared to be feasible, but unfortunately the method adopted resulted in discoloration of the end product and spoilt it for commercial purposes, thereby involving considerable financial loss. An action for damages was launched and the case proceeded up to the retention of a leading K.C. and his conference with expert witnesses. Eventually the outbreak of the first world war in 1914 brought these proceedings to a negotiated settlement.

As a matter of fact, the 1914–18 war actually called a halt to further progress of suction gas plant development, for liquid fuel was then procurable through better distribution; was more conveniently stored and as yet imported freely. Internal combustion engine makers had time to experiment with new designs and the compression volume ratio was increased with greatly improved results until instead of 40 lb compression pressures became 180 lb and the hot bulb engine became the "semi-diesel"—a term which a committee of the Diesel Engine Users' Association (then in its infancy) had some difficulty in defining with essential clarity. Once more at a meeting of the Institution of Mechanical Engineers (at Lincoln) a paper by the then chief engineer at Rustons—Mr. Livens—on "Some Lincolnshire Oil Engines," summarised the position in 1920 and all the high hopes originally deemed to be the rightful heritage of the suction gas plant then collapsed; and particularly after the British method of mechanical injection of liquid fuel proved in its turn to have decided advantages over the air injection of fuel as used by Diesel.

Second Seminar for European Sanitary Engineers

THE proceedings of the second seminar for European sanitary engineers, which was held in Rome last November, have been published by the World Health Organisation, Geneva. The seminar was held under the sponsorship of the Government of Italy, the Rockefeller Foundation and the World Health Organisation. The first seminar was held in the Netherlands in 1950; the practice, activities and problems of sixteen European countries in the field of sanitary engineering were discussed at that time, with further discussions on water supply conditions and sewage treatment, and various other allied subjects.

The proceedings of the second seminar comprises seven chapters, each including a paper and a discussion on sanitary engineering subjects. A paper entitled "The Public Health Engineer in Town, Regional and General Planning," was presented by Mr. G. M. McNaughton; a list of the various professional institutions in European countries which are concerned with sanitary engineering was given by Professor Krul in a paper entitled "Formation of National and European Associations of Sanitary Engineers." The other papers printed in the proceedings are as follows: "Considerations Involved in the Development of International Drinking Water Standards," by Professor Corti; "The Financing of Sanitary Works," by M. Sentenac; "Disposal of Excreta and Sewage from Single Houses and Small Communities," by Professor Petrik; "Sewage Treatment Plant and the Use of Sewage in Agriculture," by Professor Mozzetti, and "Utilisation of Night Soil, Sewage and Sewage Sludge in Agriculture," by Professor Petrik. The seminar was attended by delegates from sixteen European countries, and from the three sponsoring agencies.

ASSOCIATION OF EXPLORATION GEOPHYSICISTS.—The European Association of Exploration Geophysicists held its first annual meeting at Manson House, Portland Place, London, on May 22nd and 23rd. Nine technical papers were presented, covering seismic, gravimetric, tellural and magnetic methods of prospecting.

The Mechanical Handling Exhibition

THE third Mechanical Handling Exhibition and Convention opened in London at Olympia on Wednesday last, June 4th, and will continue until Saturday, June 14th. This exhibition is organised by our contemporary, *Mechanical Handling*, to provide an opportunity for all concerned with the movement, storage and transport of materials to inspect the handling equipment now available in this country.

It is only during relatively recent years that the time which can be saved and the economies which are made possible by the use of properly designed mechanical handling equipment have been fully appreciated in many establishments here. Even now many firms are not taking full advantage of the technical developments which have been made, and in quite a number of establishments the introduction of mechanical handling is still only regarded as necessary where the loads involved are beyond the capacity of manpower. A visit to an exhibition such as that at Olympia shows in an unmistakable way that properly designed and used mechanical handling equipment can be a tool which not only promotes economy but increases productive capacity.

A very large proportion of the equipment displayed by the 170 or more firms showing their products has already been described in the columns of THE ENGINEER, but at the exhibition these machines can be seen side by side, and their adaptability for various classes of work can be discussed with specialists in the subject. Every class of material, whether in bulk or in the form of packages or units, has its individual handling problem, either in the course of manufacture or storage in the factory or in transport, and it would be difficult indeed for a visitor to the exhibition not to find at least one firm which has experience with plant to cover a particular problem.

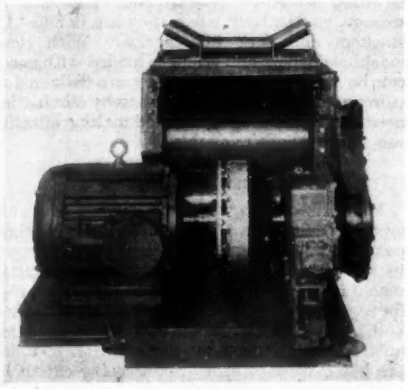


FIG. 1—60 H.P. DRIVING HEAD

The plant to be seen at the exhibition includes conveyors, elevators, hoists and pulley blocks, aerial ropeways, grain handling plants, wagon tipplers, overhead runways, mechanical loaders and shovels, plant for handling coal, coke and ash, industrial trucks, fork lift trucks, &c., and a selection of ancillary equipment. Many of the machines and some of the equipment of reasonable size are shown in actual operating condition, whilst the larger items are shown in model form or by means of photographs on the stands.

During the course of the exhibition various sessions of the convention being held at Olympia will deal with materials handling problems met with in industrial and commercial establishments, and many technical and industrial associations are taking an active interest in this convention. The scope of the convention will be appreciated from the following papers which are being presented: "Foundry Mechanisation," by J. Bain; "Installation and Maintenance Aspects of Electric Overhead Travelling Cranes," by G. V. Sadler; "Crane Duties and Maximum Stresses," by J. H. Huntley; "Materials Handling and the Production Engineer," by T. W. Elkington, J. Bright, D. H. Challinor and F. E. Rattlidge; "Mechanical Handling in Relationship to Shiploading and Discharge," by Commander A. C. Hardy; "Mechanical Aids in Industry," by K. B. Warwick; "Telphers and Runways," by B. Pollard; "Electronics in Materials Handling," by L. Landon Goodman; "The Versatility of Industrial Trucks (including Fork Lift and Industrial Power Trucks)," by L. Rumley; "Motion Study Applied to Mechanical Handling," by L. W. Bailey, and on the final day of the convention the Mechanical Aids Team will speak on case histories arising from its report, under the chairmanship of A. Roebuck.

A number of films concerned with the subject of mechanical handling are being shown during the convention, including "Conveyors as Your Servants," produced by the Mechanical Handling Engineers Association; "Prelude to Power," prepared by the contractors to the Castelo do Bode dam; "The Port of Bristol"; "Maid of All Work," produced by the Chaseside Engineering Company, Ltd.; "Farming Review," produced by Harry Ferguson, Ltd., and "Layout and Handling in Factories."

In the article which follows there is given a general impression of the scope of the exhibition and some notes on equipment shown which has not previously been mentioned in THE ENGINEER.

CONVEYORS AND ELEVATORS

Conveyors and elevators for the handling of materials in a continuous flow are shown in many forms and a number of the manufacturers of these machines have arranged "closed circuits" to demonstrate the operation and adaptability of their equipment. It will be seen that an increasing number of belt, roller, slat and other conveyors are now available in short units, which can be arranged in a variety of ways to suit individual plant layouts and production flow requirements. Several overhead conveying systems shown in operation demonstrate the flexibility of this method of transporting articles and goods where it is required to keep the floor space clear of obstruction and feed to and from fixed stations. Selector and switching gear incorporated in the overhead units of some makers can be arranged to direct individual loads away from the main flow to required stations or introduce parts into the system in required sequence. The many belts, rollers and drives for conveyors and elevators which are now available for handling materials of all kinds, still further increase their range of uses and flexibility.

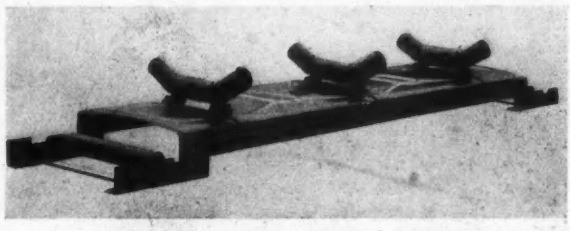


FIG. 2—BELT CONVEYOR UNIT

Amongst the heavy belt conveyor driving equipment exhibited is the 60 h.p. "Goliath" head on the stand of Richard Sutcliffe, Ltd., of Wakefield, which is illustrated in Fig. 1. This unit has a three-drum drive giving a large arc of contact with the belt and it is fitted with a fluid coupling and an electric brake. Drive from the motor is transmitted through a double-reduction gear train and belt speeds from 180ft to 340ft per minute can be obtained from a 960 r.p.m. motor, or up to 510ft per minute with a 1440 r.p.m. motor. The fluid coupling between the gear box and the motor reduces starting shocks to a minimum. When required a standard loading jib 9ft long can be supplied with the driving head for loading into tubs or on to the tail end of another conveyor.

On the stand of Mavor and Coulson, Ltd., of Bridgeton, a length of the firm's sectional belt conveyor is shown running. In these conveyor units, one of which is shown in Fig. 2, the idler rollers are carried on inverted troughs joined by angle feet. Each unit is a light rigid structure, easily installed or removed, and a conveyor is simply extended by inserting more unit lengths. In a conveyor belt driving unit on

FIG. 3—FORK LIFT TRUCK WITH CRANE FITTING

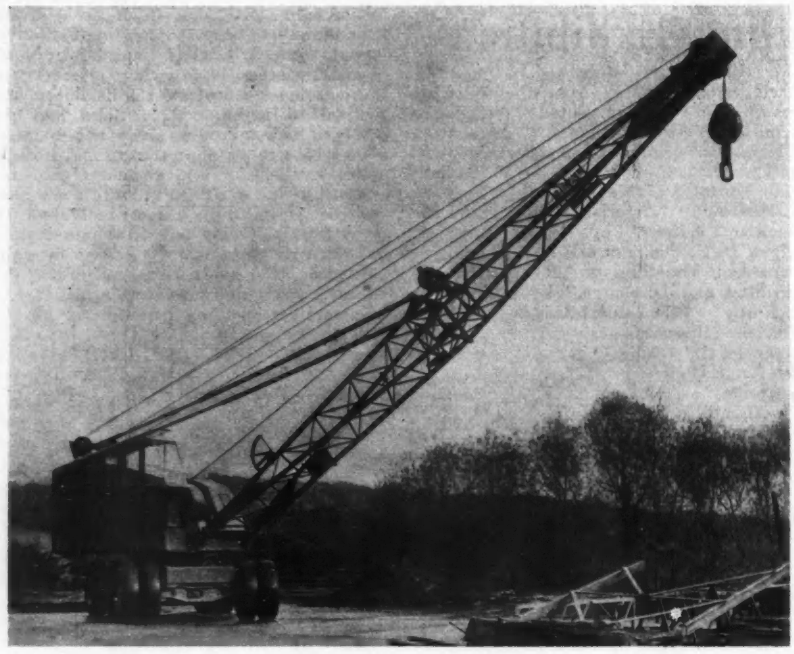


FIG. 4—10-TON MOBILE CRANE

this stand, which is designed to transmit 40 h.p. with a belt speed of 450ft per minute, the first speed reduction is by vee ropes and the second reduction through spur gears. A hold-back fitted to this head comes into effect as soon as the conveyor is stopped, and tends to reverse, to lower a ratchet which engages a pawl and arrests movement.

The Fraser and Chalmers Engineering Works of the General Electric Company, Ltd., displays an interesting arrangement of its "Sherwen" electro-mechanically operated vibratory conveying equipment. A vibrating trough made up into a screening unit separates a mixture of granules into three groups by size, each group being differently coloured for easy identification for the purpose of the demonstration. These granules are then fed to a spiral elevator by further vibratory conveyors arranged as spokes to the hub formed by the elevator. This elevator, which is in fact a cooler for use in a plastics factory, then elevates the material and, from the top of the spiral, it is finally returned for recirculation. Another interesting application of the spiral elevator in industry is demonstrated by a unit delivering material to an automatic weighing machine.

A second circular table, comprising three separate troughs, demonstrates a system of reversing the flow of a material by electromagnetic means in conjunction with half-wave rectifiers. A recently developed straight, reversible conveyor, 20ft long by 15in wide, which is shown, is capable of handling material in either direction with an output said to be comparable with that of an equal-sized standard vibratory conveyor. Another electromagnetically operated vibratory conveyor demonstrates how a continuous trough can carry material both in a straight line and around a radius.

FORK LIFT TRUCKS

Few methods of handling goods have made a greater impression in recent years than the fork lift truck. This class of vehicle with its high degree of manœuvrability, rigid construction, and speed and ease of operation has revolutionised transport and storage systems in practically every branch of industry. That British manufacturers have appreciated this fact is shown by the number of different designs of fork lift truck introduced in the past few years. At Olympia several makers are showing ranges of trucks, which now include units capable of handling loads of up to 8 tons, fitted with petrol or diesel engine or electric motor drive and hydraulic fork operation. A large number of these trucks now incorporate a fork side shifting mechanism and means for varying the fork spacing to suit various loadings. The versatility of the trucks has been greatly increased by the introduction of such fittings as gripping gear for bales, barrels, &c., buckets for loading granular materials, and soil shifting, scraper blades, &c.

Amongst many of the trucks shown and already described in THE ENGINEER are those by I.T.D., Ltd., and Conveyancer Fork Trucks, Ltd., dealt with in the issue of May 2, 1952, and the battery trucks of Ransomes, Sims and Jefferies, Ltd., in our issue of May 9th. The three machines on the stand of Matthews Brothers, Ltd., include that company's recently introduced 1 ton capacity unit, which was described in our issue of May 2nd last. This truck is mounted on large pneumatic wheels and is equally suited to working in the open on rough ground or in confined spaces in buildings. One of the largest capacity fork lift trucks exhibited is the 18,000 lb unit made by Shelvoke and Drewry, Ltd., and described in the our issue of May 23rd last. With the full load at 24in from the face of the carriage this machine can stack at heights of up to 20ft. It is driven by a 70 h.p. engine and has, in addition to a hydraulically controlled fork side shift gear, means of manual adjustment to give fork spacings from 36in to 59in.

Another high-capacity fork lift truck exhibited is one recently introduced by Ransomes and Rapier, Ltd., of Ipswich, which is made in sizes to lift from 12,000 lb to 18,000 lb. This particular machine is illustrated in Fig. 3, where it is shown fitted with a cantilever jib. This jib is used for reaching and lifting from positions which are inaccessible to the forks. It does not interfere with the handling of normal loads with the forks, and it can quickly and easily be fitted to or removed from the machine. The trucks are available with either petrol or oil engine drive, travel drive being taken direct from the engine through a gear box. A hydraulic pump supplies power for hoisting and tilting of the mast.

Hand and power-operated platform trucks have been in general use in industry for very many years, and steady development has considerably widened their range of application. Many different designs and sizes of these trucks are exhibited and they include both hand and power-driven models with fixed, adjustable, tipping, self-loading, lifting and other kinds of platforms to suit all classes of work.

As fork lift trucks, stackers and platform trucks have developed and their uses increased, so have the designs and types of stillages and pallets which are complementary to them for the efficient handling of many forms of goods in bulk. Many pallets and stillages are, of necessity, specially designed to suit the work handled; but, as can be seen from the variety at Olympia, a number of standard designs of mass-produced units now being made can be adapted for a wide range of application. Not only are these units a valuable medium for making the most effective use of different forms of transport, but they can be used to solve many space problems in storage, particularly when they are handled by stackers and fork lift trucks. With these machines pallets and stillages loaded with goods can be stacked in tiers as they are delivered to stores areas and warehouses, thereby eliminating need for fixed storage racks and making effective use of the height available.

CRANES AND HOISTS

Many different makes and designs of mobile cranes which have been described in these columns have shown the steady progress made in the size, capacity and versatility of these machines in recent years. Such cranes adapted for road travel, with their large lifting capacities and jibs which can be extended to a considerable effective length by the addition of units, are being used to an ever-increasing extent by contractors on remote sites, where it would not

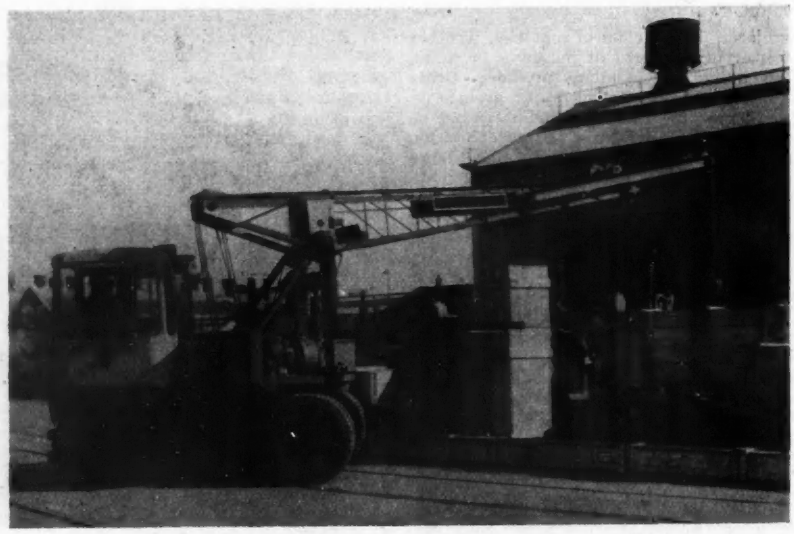


FIG. 5—MOBILE CRANE

normally be economic to erect fixed cranes. Several makes of these cranes are to be seen side by side at the exhibition, and interesting comparisons can be made of their various parts in design and operation.

One of the largest mobile cranes exhibited is the 20 tons capacity machine made by Steels Engineering Products, Ltd., and described in our issue of April 18th last. This machine is fitted with a standard 30ft jib, which by adding centre sections in 5ft long increments can be extended to a maximum length of 80ft. With the machine jacked up on outriggers and using a 30ft. jib a maximum load of 20 tons can be lifted and slewed through a full circle at 10ft radius, or 5 tons at 30ft radius. With the machine on its wheels it can lift from 11½ tons at 10ft radius to 2½ tons at 30ft radius over the rear, and from 7 tons at 10ft radius to 2 tons at 30ft radius over the side. When an 80ft jib is fitted and outriggers are used up to 1 ton can be lifted at 73ft radius or 12 tons at 14ft radius.

The 10-ton mobile crane made by R. H. Neal and Co., Ltd., described in our issue of February 23, 1951, and illustrated on page 756 (Fig. 4), is shown fitted with a 75ft jib. It is a full-circle slewing unit, designed to lift, without the use of outriggers, a load up to 10 tons and travel with the load under its own power. It can be fitted with a 30ft swan-neck jib or lattice jibs, 45ft, 60ft or 75ft. long. The swan-neck jib is used for handling the maximum load of 10 tons at 11ft 6in radius and lattice jibs are fitted when the crane is required for raising lighter loads at greater radii. With a 45ft lattice jib the crane can lift up to 6 tons to 43ft at 16ft. radius; with a 60ft lattice jib up to 4 tons can be raised to 57ft at 21ft radius, and with a 75ft lattice jib up to 2½ tons can be raised to 71ft at 26ft radius.

The Jones "KL66" mobile crane marketed in this country by George Cohen Sons and Co., Ltd., is being shown for the first time at the Mechanical Handling Exhibition. When this machine is fitted with a 20ft swan-neck jib or a 25ft channel jib the crane is capable of handling loads from 2 tons at 18½ft radius to 6 tons at

FIG. 6—5-TON CRAB

9ft radius. Jibs of lattice construction up to 60ft long can be fitted for handling lighter loads at greater radii. Each of its four motions, hoisting, slewing, travelling and derricking, is independently operated and is reversible. The crane was illustrated and described in some detail in our issue of March 2, 1951.

One mobile crane exhibited, which has not previously been described in THE ENGINEER is that illustrated in Fig. 5, made by Ransomes and Rapier, Ltd. It can be fitted with jibs giving lifts between 14ft and 31ft above ground level and its load capacity varies between 5 tons at 3ft 6in outreach to ½ ton at 25ft 6in outreach. The machine has a full-circle slewing superstructure and is powered by a 38·5 Perkins oil engine or a 41·5 Morris petrol engine driving a generator. Its four motions, hoist, derrick, slew and travel, are each operated by electric motors. The crane weighs some 12½ tons and is carried on pneumatic wheels. The front wheels are mounted on a fixed axle, whilst the other two—the steering and driving wheels, are mounted on a caster which is pivoted to a kingpost in the tail of the crane. This pivotal attachment enables the caster wheels to accommodate themselves to uneven ground, so that the crane is always steadily supported on three

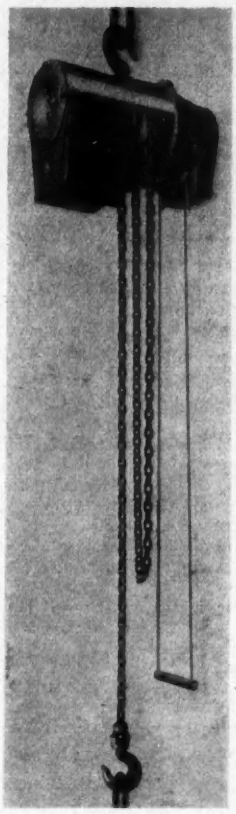


FIG. 7—CHAIN HOIST

points, and it can, if necessary, be rotated about the midpoint of its front axle.

The makers of fixed and overhead travelling cranes of different kinds are also represented in the exhibition, and their heavier equipment is mostly shown by means of photographs and models. One of the heavy pieces of crane equipment shown on the stand of the Wharton Crane and Hoist Company, Ltd., of Reddish, Stockport, is a 10-ton, three-motor, heavy-duty, cage-controlled, overhead travelling crane of 40ft 7½in span. This crane is fitted with an enclosed crab, and it has Metrovick stable a.c. "Stacreep" creeping control for the hoisting and lowering motions.

The "Stacreep" system of crane and hoist control developed to give stable creeping speeds with a.c. motor drives is demonstrated by the British Thomson-Houston Company, Ltd., as a working exhibit on a complete crane crab made by Joseph Booth and Bros., Ltd. This crab is mounted on crane rails some 14ft above the ground to simulate an actual installation and is operated by pendant push-button control.

"Stacreep" control consists, basically, of a spring-applied "Thrustor"-controlled brake with the "Thrustor" connected across the main motor slipring. When the main motor is energised initially the "Thrustor" receives full line volts at line frequency, and lifts the brake shoes clear of the brake drum, thus allowing the main motor to accelerate. As the motor accelerates the rotor frequency falls; so does the speed of the "Thrustor" motor. In consequence the brake is gradually applied until a stable condition is reached where load and braking torque is balanced against the motor torque. The speed at which this condition is reached is dependent on the characteristics of the various components of the equipment. "Stacreep" control is normally arranged to be effective on the first two points of the controller in either the hoist or lower direction. On the remaining controller points the "Thrustor" is energised from the main supply so that the brake is completely lifted.

The many hoist blocks to be seen show how developments in design have led to the construction of compact units requiring a minimum of headroom despite increasing load-raising capacities. The crab illustrated in Fig. 6 is made by Matterson, Ltd., of Shawclaugh, Rochdale, and is a four-motor, 5-ton unit. It is built on a co-axial "chassisless" principle and its compact arrangement gives good hook approaches with moderate weight.

This hoist is arranged to lift 5 tons at 9ft to 18ft per minute and 7in or 14in per minute, travelling at 30ft to 70ft per minute and at 2ft per minute. The higher speeds are obtained direct from main motors driving across epicyclic gears. The creeping speeds are obtained by electro-mechanical means from auxiliary motors driving the cages of the epicyclic gears. The reliability and simplicity of squirrel-cage motors and direct-on switchgear are thus retained. It is pointed out that the unusually low creeping speed, unaffected by variations in the load or the period for which it is held in operation, renders the equipment especially suitable for foundry and assembly duties.

Amongst the lifting gear shown by the Vaughan Crane Company, Ltd., of West Gorton, Manchester, there is a 3-ton travelling crane fitted with variable speeds on each motion and operated by remote radio control. The "Vestrad" radio control unit used is applicable to all classes of overhead cranes, which this firm makes in a range of capacities from 1 to 200 tons, fitted with contactor gear for the various motions.

From recently introduced designs of hoist blocks shown by Herbert Morris, Ltd., of Loughborough, we have selected for purposes of illustration the unit in Fig. 7. This chain hoist is made in three capacities—¼, ½ and 1 ton—and has a built-in motor. It is controlled through a pendulum handle and in addition to a self-sustaining load brake coupled to the

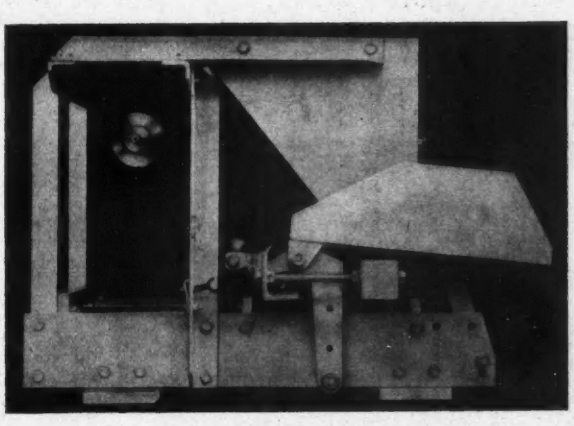


FIG. 8—VIBRATORY FEEDING UNIT

shaft through gearing has a nipper brake designed to sustain the full load independently. A lever unit operated by the chain is designed to cut off the current through the switch in the event of over-running.

For very many years Simon Handling Engineers, Ltd., of Cheadle Heath, Stock-

port, has specialised in the pneumatic handling of free-flowing granular materials and three of the main exhibits of this firm are concerned with pneumatic handling equipment. One of these exhibits is a sectional model of the 300 tons per hour floating pneumatic grain discharging plant, "John Anderson," built for the Port of London Authority. Another model of a pneumatic conveying system is of interest as in it the material can be seen circulating through glass pipes in the "closed air circuit" system, whereby the conveying air is continually recirculated and prevents the escape of fumes or dust to the surrounding atmosphere, whilst the material being handled is protected from contamination.

A piece of general mechanical handling equipment exhibited by this firm is the "Velo-feeder," illustrated in Fig. 8. In this unit material from the superimposed hopper is fed at an infinitely variable rate by the oscillating tray. When the feeder is in operation the tray oscillates between two springs and at the limit of its forward movement it contacts an anvil which is also oscillating between a second set of coil springs. At the moment of contact the anvil has reached the limit of its

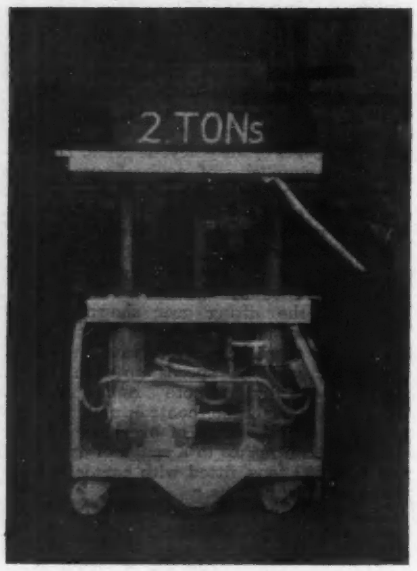


FIG. 9—LIFTING TABLE

rearward stroke so that the two masses vibrate in opposite phase. Oscillation of the anvil is maintained by a rotating eccentric weight driven by a fractional horsepower motor. By moving the two masses nearer together or further apart by means of a hand wheel the amplitude of vibration of the feed tray is altered to diminish or increase the force of impact and control the rate of discharge.

In the course of manufacture and transport in factories and other industrial establishments, it is often necessary to move units between two levels, such as when loading vehicles or conveyors, raising work to machine table level, &c. Single-purpose lifting devices are often designed to suit individual requirements in this class of handling, but there are also general-purpose units available which are suitable for various applications. One firm at Olympia showing both special and general-purpose units of this kind is Equipment Repairs, Ltd., 19–20, Alperton Viaduct, Alperton, Wembley.

The machines made by this firm are generally designed with two hydraulic cylinders mounted on a heavy rigid base and supporting a table on which the load is carried. The cylinders are fed with pressure fluid from a common source, and irrespective of the even or uneven loading of the table it remains level throughout its movement. In Fig. 9 there is illustrated one of this company's portable lifting table units which was designed for the transport and positioning of tools weighing up to 2 tons on presses in a large factory. The motor-driven hydraulic unit of the leveller is totally enclosed in the base, and movements of the table are controlled to raise, lower, and sustain the load at any required level.

Of interest to firms exporting equipment fitted with electric motor drives is the new type "KNB" totally enclosed fan-cooled squirrel-cage motor now made by the Metropolitan-Vickers Electrical Company, Ltd., with standardised fixing dimensions to the American N.E.M.A. specification. These motors have been developed side by side with other leading British manufacturers in order to meet the demand for interchangeability of motors. An important advantage of this design is that, although a compact arrangement has been maintained in accordance with accepted British practice, it is possible to supply "KNB" motors to American N.E.M.A. standards by the use of a larger frame size and slight modifications to the shaft. This means that mechanical interchangeability with U.S. or Canadian-built machines is a simple matter.

The motors are made in eight frame sizes from 1 h.p. to 20 h.p. for four-pole machines, and the 2 h.p. and 15 h.p. motors are exhibited.

The Marshalling Yard at Toton

No. I

The new "up" marshalling yard at Toton, embodies the experience gained with several large mechanised yards in this country, and the results of studies of similar operating practice overseas. Some novel features have been introduced into the signalling arrangements to provide for rapid handling of heavy mineral trains and the clearing of light engines. The new yard was constructed largely on the site of the existing one, but by careful progressing of the work, and use, for a short time, of certain sidings in the fully mechanised down yard, traffic was kept flowing without delay during the two and a half years of the changeover period.

IN our issue of November 23, 1951, we published a general account of the new mechanised marshalling "up" yard at Toton, London Midland Region, British Railways, for dealing with westbound and southbound freight traffic. The equipment of the new yard, and the procedure by which the layout was brought into service present many features of particular interest, and in this article we are describing in some detail the new signalling arrangements and other engineering work involved in the changeover. During the latter period the volume of traffic handled before the new facilities were put into commission continued to flow without interruption.

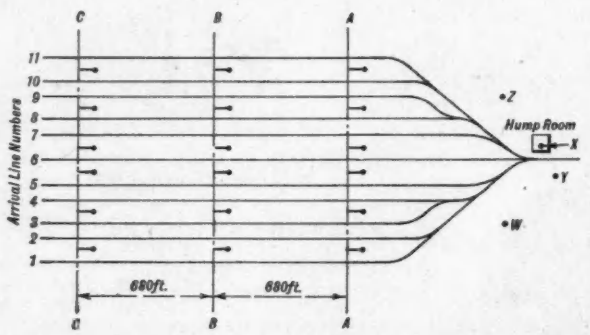


FIG. 1—DIAGRAM OF ARRIVAL LINES AND HUMPING SIGNALS

SIGNALLING

The application of modern railway signalling practice to the handling of freight traffic in a fully mechanised marshalling yard has been discussed on several previous occasions in THE ENGINEER, and at Toton "up" yard the basic principles remain the same as at the down yard. Experience with earlier lay-outs, however, has shown the need for various refinements of control, and this applies particularly to the establishment of close liaison between the driver of the humping engine on the one hand, and the operators in the hump room (at the crest of the hump) and those in the control tower (from which the rail brakes are worked), on the other. All the points in the hump area of the new yard are automatically worked, the routes being set up by the hump room and transmitted electrically to the control tower as the wagons approach the hump. At the same time a visual record is made in the control tower on a teleprinter mechanism. The system is different, therefore, from that employing cut cards, and in fact allows a train to be humped as soon as the engine has been released.

The procedure for automatic setting of the points leading to the classification sidings, after wagons have been propelled over the hump, will be described later, but at this stage it will be enough to appreciate that if the speed of humping is too high successive wagons descending the steep gradient from the hump will not separate sufficiently for the points to be thrown, should it be necessary to route successive wagons, or group of wagons coupled together—"cuts," as they are known—on to different roads. The inconvenience and delay of wrong shunts will then be experienced. Trouble on this account in earlier installations led to the decision to provide special signalling facilities to assist the humping engine drivers in maintaining a suitable speed. The method of doing this is the principal innovation, so far as signalling is concerned at Toton.

There are ten arrival lines, as shown diagrammatically in Fig. 1, on each of which a freight train can be berthed. Southbound trains are drawn into one or other of these sidings by the main line engines, and brought to a stand with the engine just short of the appropriate signal on line *AA*, see Fig. 1. The configuration of these signals is something quite apart from ordinary railway signalling, in that they include means for displaying two quite dissimilar sets of indications: one applying to the train engines and the other for regulating the speed of the diesel humping engines. Furthermore, to economise in yard space and reduce the total number of signals required, each configuration is designed to cover the needs of the adjacent arrival lines. A diagram of one of these signals is shown in

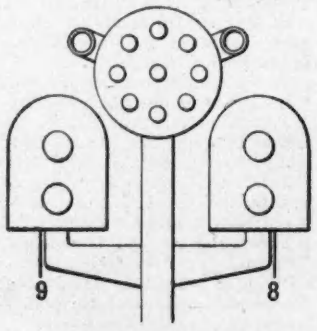


FIG. 2—HUMPING SIGNAL

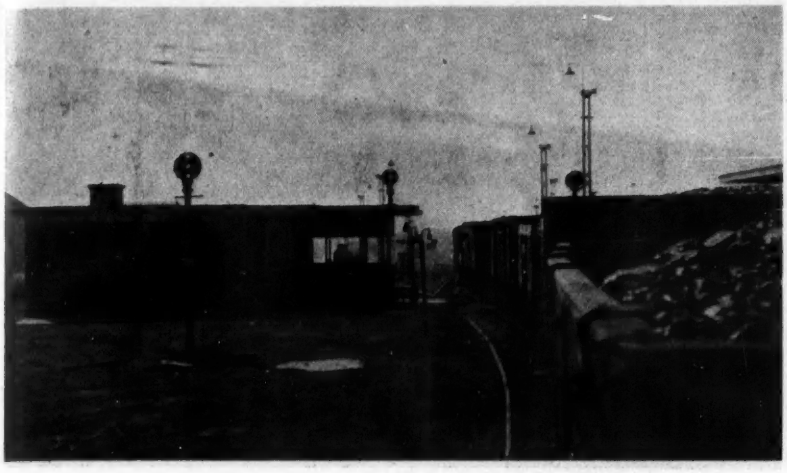


FIG. 3—ADDITIONAL HUMPING SIGNALS SEEN FROM THE HUMP CREST

FIG. 4—HUMP ROOM CONTROL PANEL AND DIAGRAM

FIG. 5—STAPLEFORD AND SANDIACRE SIGNAL BOX INTERIOR

Fig. 2. The two-aspect colour light signals immediately above the figures 8 and 9 can show either red or green, and are used solely for controlling the movements of train engines. The figures suspended from the brackets refer to the number of the arrival lines concerned, as shown in Fig. 1, and are seen against a sky background or against the illumination of the yard floodlighting at night. The signals themselves normally show red and remain so while an arriving train draws up. When the train engine has uncoupled and the road is clear for it to proceed to the engine release line the signal displays green.

The hump engine signals, in the centre of the configuration shown in Fig. 2, are of the position light type, and their indications are displayed in a row of three white lights, as shown in Fig. 6. Differentiation between the two adjacent lines is provided by the wing, or "applicability" lights, which are also lunar white. In addition to the special combined signals on the line *AA*, in Fig. 1, there are humping engine signals on lines *BB* and *CC*, but these do not have the colour light train-engine signals combined with them. The

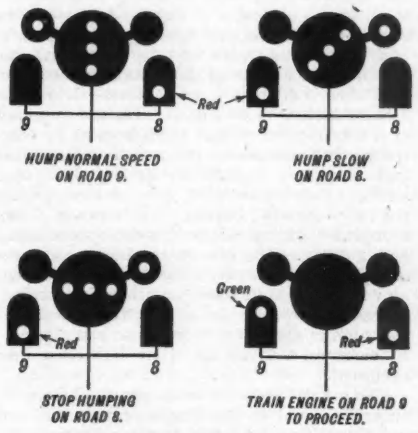


FIG. 6—HUMP ENGINE SIGNALS

humping signals on lines *BB* and *CC* are double sided, and from reference to the dimensions given in Fig. 1 it will be seen that in progressing towards the hump a locomotive is never more than 340ft from one of the speed signals. When humping is in progress the "train engine" aspect on the signal at line *AA* is extinguished altogether. Similarly the hump engine signals are extinguished when train engine movements are in progress. Control of the indications displayed by the hump engine signals is through a master switch on the control panel of the hump room, whereby the operator can signal "hump at normal speed," "hump slow," or "stop," as shown by the indications in Fig. 6. While it is thus true that this last row of humping signals on line *AA*, Fig. 1, are out of the ordinary, they do display the usual red indication for each arrival line, and green for engine release. The special aspects are displayed only for humping purposes when the normal red for the particular line is extinguished.

In addition to the signals on lines *AA*, *BB* and *CC* there are four further hump engine signals at positions *X*, *Y*, *Z* and *W* (see Fig. 1) to assist the driver in regulating the speed as his locomotive draws near to the hump itself and ensure that a driver shall have a continuous sight of one or other humping signal when on the curves at the convergence of the arrival lines approaching the hump. This was not easy to arrange, bearing in mind that the engine may be pushing high-sided vans, and that the necessity for the driver to change his driving position from one side of the locomotive to the other should be reduced to an absolute minimum. These signals *X*, *Y*, *Z* and W are controlled from the same master switch, while the appropriate arrival line humping signals are illuminated by pressing the corresponding selector button on the panel. For reasons to be described later, the operator in the control

tower is provided with an over-riding control and can set the humping signals to "stop" at any time should this be necessary. In the engraving Fig. 3 herewith the humping signals *X*, *Y* and *Z* are shown, as seen from the cab of a diesel locomotive engaged in humping. These signals are all displaying the indication "hump at normal speed." It should be added that these signals work in unison with whichever set of arrival line humping signals has been selected. In this illustration it will be noticed that the operator in the hump room is very well positioned for observing the progress of a train over the hump. A view inside the hump room is reproduced in Fig. 4.

Before proceeding to the work of route setting and control of wagons on the descending side of the hump there are some further details of interest to be noted on the arrival side. Entrance to the arrival lines is controlled by the new main line signalbox at Stapleford and Sandiacre Station. The cabin is a large one of 115 levers, with two men on each shift, and is a reporting post for the main line traffic control; the link-up with the hump room has been devised so as to necessitate the minimum of communication. The interior of the Stapleford and Sandiacre box is shown in Fig. 5. Ordinarily there are no messages of any kind between the two boxes. Indicator lights are provided in both the hump room and in Stapleford and Sandiacre box showing the occupancy or otherwise of each of the ten arrival lines—1 to 5 and 7 to 11 inclusive, in Fig. 1. On the approach of a southbound freight train booked to enter the yard the signalman concerned at Stapleford and Sandiacre selects an arrival line from among those unoccupied, and he then presses the appropriate button, to indicate "line occupied" and to release the semaphore signal giving entry. The man in the hump room can also press up "line occupied" if for any reason he wishes to shunt back, or otherwise preclude a train from entering at the Stapleford end. The man in the hump room alone can "press" to clear an arrival line that has once been occupied.

The arrival lines are track circuited from the entering signal to the clearance point in each individual line, and the track indications are shown on an illuminated diagram of a novel

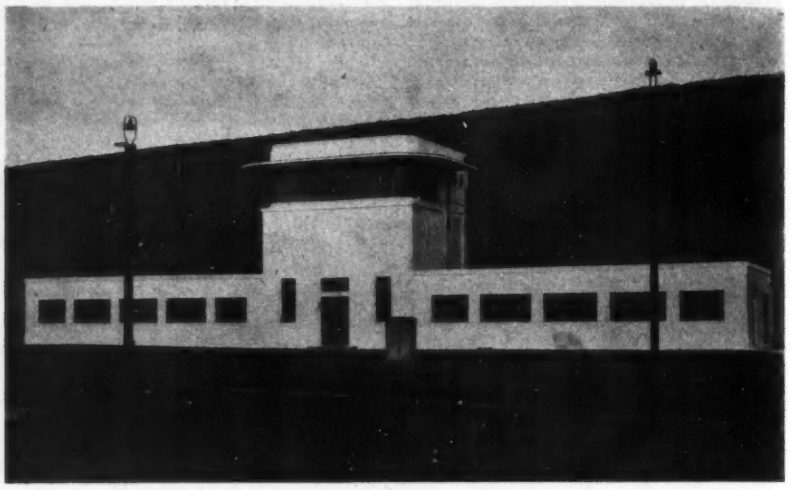


FIG. 8—CONTROL TOWER—TOTON "UP" YARD

type, first introduced in 1951 at Agecroft Junction and incorporated now in the modifications at Stapleford and Sandiacre needed to fit in with the equipment in the new Toton southbound yard. It was formerly the practice of the London Midland Region to paint the track diagrams by hand on paper mounted on to plywood backgrounds. The new practice is to print the diagrams by true-to-scale process direct from the master drawing on to a sheet of white plastic material 20 thousandths thick; colouring, where required, is readily added, and the plastic sheet is then mounted on a wooden board. One of the advantages claimed for this method is that alterations to a diagram necessitated by changes in track lay-out or signalling arrangements are easily made, since any part of the impression can be readily scraped off the plastic sheet and new details inked in by hand.

Turning now to that part of the yard lying beyond the crest of the hump, the lay-outs of the classification sidings, and the manner in which they are track circuited is shown in Fig. 7, while the lay-out of the old yard as it was is shown in Fig. 10. The operation of the points to set the various routes required is automatic throughout each route once the original storage has been set up. Route setting is initiated by the operator in the hump room, as described in our previous article dealing with the yard in general, and the apparatus is so designed that the routes of successive "cuts" can be registered, or "stored" as it is termed, before the previous cut has cleared the first pair of diverging points—the "king" points. Storage is effected by means of rotary switches of similar design to the rotary uniselectors used in automatic telephone switching, and it is possible to "store" four routes on the first set of storage switches, this being considered the maximum number of "cuts" that it is physically possible to have between the crest of the hump and the "king" points. Setting of the "queen" points (see Fig. 7) is effected by a progression relays following the working of the first set of storage switches.

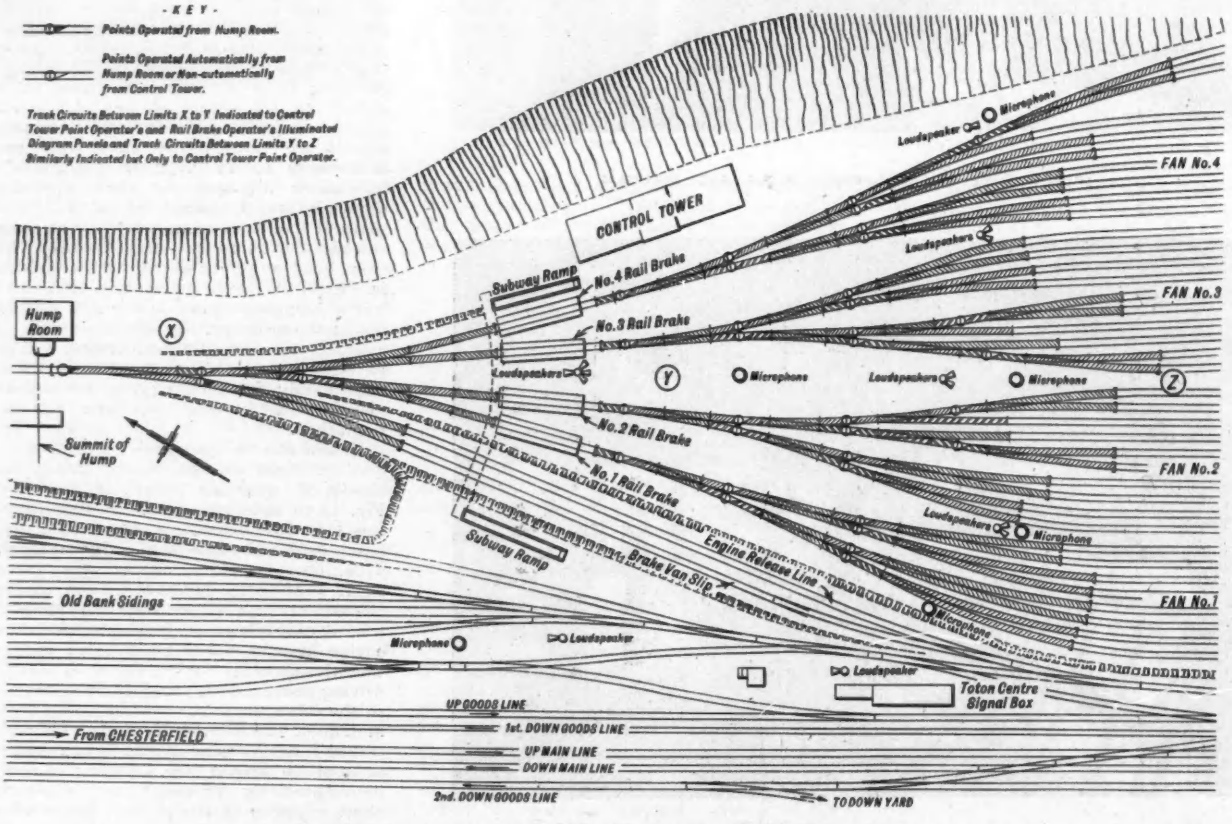


FIG. 7—LAYOUT OF NEW YARD SHOWING TRACK CIRCUITING

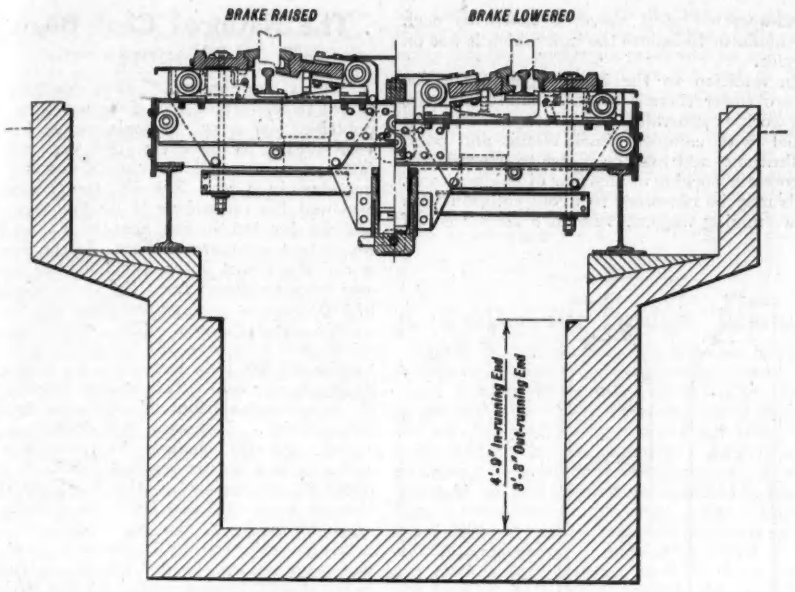


FIG. 9—RAIL BRAKE AND INSPECTION PIT

After passing over the "queen" points descending cuts come to the rail brakes. The portions of track that include each of these latter cannot be track circuited, and the sequence of relay-controlled progressive steps in the process of automatic point setting cannot be continued by the functioning of successive track circuits. Storage is therefore transferred electrically to a further set of rotary storage switches preceding the passage of the "jack" points (see Fig. 7). The storage for the "jack" and subsequent points is actually transferred from the "king" storage when the cut is running over the "king" points. The setting of the remainder of the points on each route is controlled by progressive relays, set in action, step by step, as the "cuts" pass over successive track circuits. As no passenger traffic is involved the usual track circuit principle of normal energisation, with the relay becoming de-energised when a vehicle enters the section concerned, can be reversed, and the tracks kept normally dead. Speed is of first importance in mechanised marshalling yard operation, and the fact that d.c. relays pick up quicker than they drop away has led to the standardisation of normally dead track circuits in marshalling yards. If such a track circuit failed to become energised on the entry of a wagon, and this resulted in a wrong shunt, or even in a collision between wagons, this remote chance of delay is considered a risk worth while taking to secure the quicker response of the relays in normal conditions.

The points are electro-pneumatically operated and all relays are of the "plug-in" type.

Although the process of route setting is initiated from the hump room, the storage switches, relays and other apparatus concerned are housed in the control tower. This, it will be appreciated from one of the accompanying engravings, Fig. 8, is a handsomely designed building in a distinctive style. In general, flat-topped buildings have almost always been used for hump yard control towers in British marshalling practice.

RAIL BRAKES

The operation of the rail brakes is controlled from the tower, and although these appliances were first introduced into British marshalling yards some twenty-five years ago, the number of of fully mechanised yards is still few. We include herewith a drawing (Fig. 9) of the type of brake installed at Toton southbound yard. There are considerable differences in the running qualities of freight wagons, and the purpose of rail brakes is to check the free runners. The speed of humping must necessarily be a compromise to suit average runners, and in such conditions the freer ones would, if unchecked, attain higher speeds than desirable when descending the hump, and come into violent contact with wagons already in the particular siding to which they were routed, with risk of damage to goods or derailment of the wagons themselves. Control of the amount of retardation to be applied to any one cut is a matter of experience and judgment on the part of the operator. To safeguard against the risk of humping continuing in the event of a derailment or wrong shunt taking place, an overriding control is provided in the control tower, whereby the hump engine signals can be put to danger at any time and humping stopped. The operation of the brake will be appreciated from the cross-sectional drawing Fig. 9, of which the left half shows the brake raised and the beams in the act of gripping the wagon wheels, while the right half shows the brake lowered and the wheels free to run through.

While the design of the brakes is similar to that in use at Toton down yard and elsewhere, the lay-out on the "up" side is much improved, in that concrete pits are provided underneath of sufficient depth to permit easy access to working parts for cleaning and maintenance. Hydraulic pressure for operating brakes is maintained by an air-hydraulic accumulator instead of the "weight" type, used in the equipment for Toton down yard. The arrangement of the accumulator is shown in Fig. 11.

This equipment consists of two independent 30-gallon accumulators, each with its own control gear, arranged so that either can be on duty and the other act as a standby. Each accumulator consists of two forged steel vessels

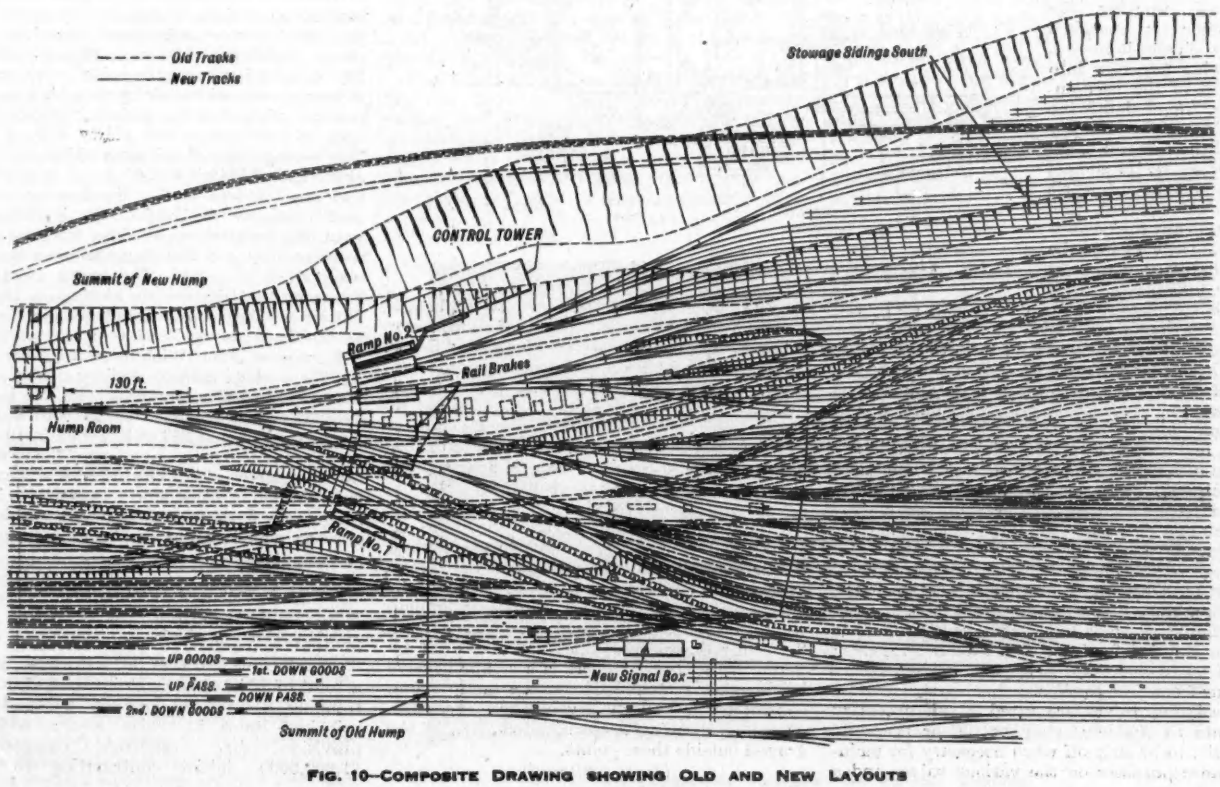


FIG. 10—COMPOSITE DRAWING SHOWING OLD AND NEW LAYOUTS

or bottles, connected together, one of which contains compressed air only, the other containing the hydraulic fluid with a volume of compressed air above it.

Each accumulator is designed for a maximum working pressure of 1600 lb per square inch, and the volume of compressed air in each is such that the normal working capacity of 30 gallons of fluid can be drawn off with a pressure drop of approximately 10 per cent.

The control gear for each accumulator consists of three control units, one acting as a pump start unit, when approximately 10 gallons have been drawn from the accumulator; one acting as a pump stop unit at high fluid level when this amount of fluid has been returned to the accumulator, and one acting as a low fluid level safety device to close down the automatic stop valve when the full 30 gallons has been drawn off and thus prevent the compressed air escaping down the hydraulic system.

Each control unit consists of a balance arm mounted on knife edges and carrying a large mass of very light metal at one end and a small mass of very dense material on the other end. The sizes and weights of these masses are so adjusted that the large mass is heavier in air, but lighter in liquid than the small mass, which has the higher specific gravity. The rise or fall of liquid in the bottle is reproduced in the control tube to which these units are connected and the balance arms are tipped over one way or the other as the liquid level rises to or drains from them. This movement varies the induction in a coil mounted on the outside of the unit which actuates relays to perform the necessary control operations.

The automatic stop valve itself is essentially a non-return valve held open by an electro-hydraulic thrustor. In normal working the thrustor is energised and the valve is opened, allowing free flow into or out of the accumulator. Immediately the liquid reaches the low level the thrustor is de-energised by the control unit and the automatic stop valve closes, preventing any further outflow. Delivery into the accumulator can, however, take place provided that a pressure differential is built up by the pump to open the valve, but flow out of the accumulator cannot occur until the thrustor has been energised by a control unit at a higher level. This ensures that adequate volume has been pumped back into the accumulator before it again goes on to service.

A high-pressure safeguard is also fitted in the form of a pressure gauge with electric contacts, which stop the pump should the pressure rise to a figure slightly in excess of the normal maximum figure of 1600 lb per square inch.

One three-stage air compressor is supplied to charge either of the accumulators as required. It is used (*a*) for the initial charge when the accumulators first go on to service; (*b*) for any further charging after either accumulator has been emptied for inspection or other reasons; and (*c*) to make up such leakage loss as may occur from time to time.

Isolating valves are fitted at all necessary points to enable the air bottle, or the fluid bottle, to be shut off when necessary for maintenance purposes on the various valves and a hand-operated stop valve is fitted to each accumulator to isolate the unit which is not on service.

In addition to the brake operator in the control tower, there is a second man to supervise the working generally, and he stands at a point panel (with complete track circuit and point indications) and has the power to override the automatic working of any pair of points at will. This may be necessary to avoid collision with slow running wagons. Should a second set of wagons catch up with a previous set before reaching the jack points, when, of course, any subsequent cuts would be out of step and hence wrongly routed, the point panel operator can press a button and step the storage, and thus restrict the wrong shunt to the second set of wagons only. The rail brake operator has a sufficiency of track circuit indications to enable him to judge the speed of wagons approaching any rail brake during bad visibility.

The only signals provided in the hump area for movements in the opposite directions to the normal flow of traffic are two short-range colour light signals from the engine and brake release lines. Any movement from the marshalling sidings back towards the hump (e.g., pulling back to resort, or an engine returning from "pushing down" a siding) are controlled by verbal instructions. There is a comprehensive loudspeaker system between the hump room, control tower and the signalboxes concerned, as well as speaking to the shunters, &c., on the ground outside these points.

(To be continued)

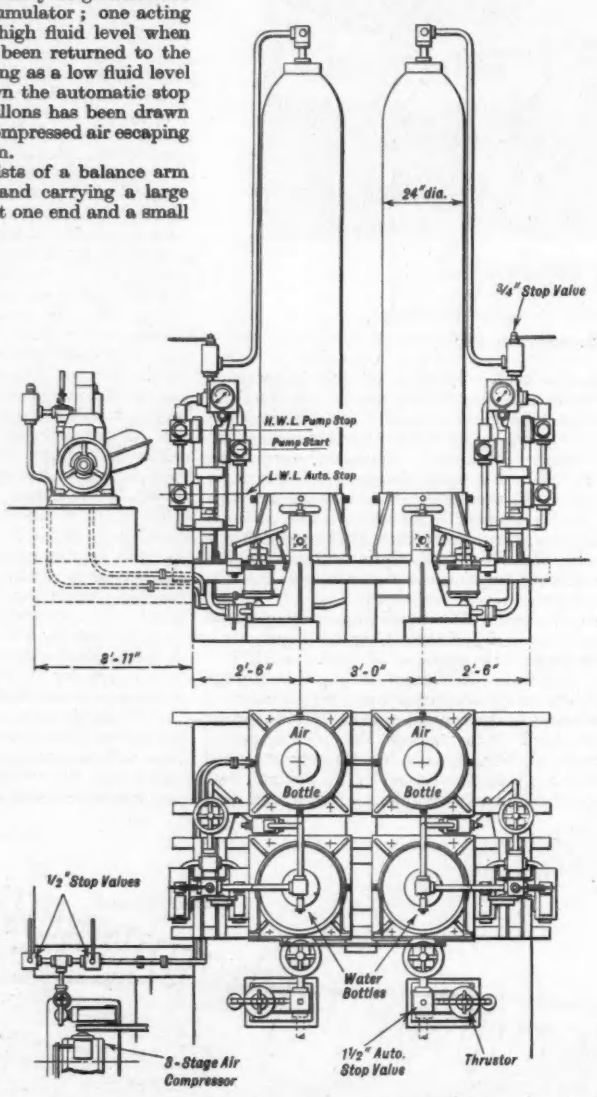


FIG. 11—AIR-HYDRAULIC ACCUMULATOR LAYOUT

The National Coal Board's Report

THE sixth annual report of the National Coal Board to the Minister of Fuel and Power was published last week. It deals mainly with the year 1951. As, however, last year was the fifth year of public ownership of the coal industry in Great Britain, the Board has reviewed the operations of its first five years and has devoted the first chapter of the present report to a summary of them. In the five-year period the report notes, 1,003,500,000 tons of coal were produced from the deep mines and 57,700,000 tons were gained from the Government's opencast sites. The output of deep-mined coal rose from 181,200,000 tons in 1946 to 211,900,000 tons last year, an increase of nearly 17 per cent. This steady increase over the five years is attributed in the report to higher productivity. Increases and decreases, it is stated, through changes in manpower and shifts worked per man cancelled out. It is also noted in the review of the five-year period that, between 1947 and 1951, the pithead price of coal rose by 27 per cent, while wholesale prices generally rose by 70 per cent. Costs rose with wage increases in 1947, but remained steady in the three following years. At the beginning of 1951 costs were slightly lower than in 1948, but they then rose sharply, the wage agreements of January and December accounting for half the increase in costs last year, compared with 1950. The other main cause of the increase in costs since 1947 is given as the general rise in the prices of materials, over half the increase from this cause occurring in 1951.

Dealing specifically with 1951, the report says that the results, in the main, were not disappointing. Production from the deep mines, at 211,900,000 tons, was 7,800,000 tons more than in 1950, which was a bigger increase than was at one time expected. Output per man-year was the second highest for half a century, and output per manshift was the highest ever. But about three-fifths of the extra output came from the extension of Saturday working, from which, the report observes, "little further increase can be expected." There were "a few more" miners in 1951 than in 1950, and on the average each man helped to produce 10 tons more coal than in the preceding year.

The coal mining industry gained 9300 men in 1951 and at the end of the year there were 698,000 on colliery books, but the report says that the industry still faced a serious manpower problem. Although during last year 20,000 juveniles were recruited, the wastage among young mineworkers was high and the number of men in the industry between the ages of twenty-one and thirty fell by 7600. The average age of miners continued to rise; at the end of 1949 it was 40·1 and by the end of last year it was 40·5. Furthermore, whilst total manpower in the industry increased last year, the proportion of face workers to all workers declined, the average over the year being 41·1 per cent. The report points out, however, that despite the decline in the proportion of face workers, output per manshift at the face rose to 3·17 tons last year from 3·11 tons in 1950. With more Saturday working the average man on colliery books worked 250 shifts in 1951, compared with 245 in 1950. In 1937 it is estimated that the shifts worked per man numbered 263. Although in 1951, the report comments, the number of shifts worked by each man was high, the industry still suffered from irregular attendance, and "it is the irregularity more than the amount of voluntary absence which causes inefficient working and loss of output."

FINANCIAL RESULTS

The National Coal Board's operating profits in 1951 amounted to £23,995,793, to which "other income" of £287,367 was added, making a total of £24,283,160. From that, deductions totalling £11,533,563 had to be made, the principal items in which were: additional provision for workmen's compensation, £1,600,000; initial contribution to mine-

workers' pension scheme, £2,000,000; estimated liability for profits tax, £2,000,000; and the loss on imported coal, £5,495,117. The profit for the year was thus reduced to £12,749,597 (compared with £22,784,662 in 1950), which sum was not sufficient to meet the interest and interim income payable to the Minister of Fuel and Power. As that amounted to £14,500,000, the Board had to report a deficiency at the end of 1951 of £1,750,403, compared with a surplus of £8,284,662 at the end of 1950. In 1951, the report records, the Board came close to wiping out the remaining £4,000,000 of its deficiency. By the end of the third quarter a surplus of £3,300,000 had been made in spite of the cut in coal exports, but for the last five weeks of the year the Board was paying higher wages without a compensating increase in the price of coal. The result was the deficiency of £1,800,000 for the year, making the total outstanding deficiency £5,800,000. Taking the whole of last year, the Board received 51s. 2d. per ton of saleable coal, the costs per ton being as follows: wages and connected charges, 32s. 3d.; materials, stores, repairs and power, 10s. 11d.; other expenses, 4s. 1d.; depreciation, 1s. 11d. In the last quarter of last year the average earnings per week for all workers in the mining industry, including the value of allowances in kind, were £11 3s. 5d., the average earnings of underground workers being £11 17s. 7d.

Technical Development

Three chapters of the report are devoted to technical matters. They are entitled "Developments in the Mines," "Carbonisation and Other Activities," and "Science in the Industry." In the first of these chapters it is noted that, by the end of last year, the Board had approved the sinking of seven new collieries and sixty new drift mines, and that major reconstruction schemes for eighty-one collieries had been approved. The estimated capital cost of all these projects is put at about £115,000,000.

The report goes on to say that last year more than two-thirds of longwall coal was cut by machine and carried away by conveyors, but only about 3 per cent of it was power-loaded. About 20,000,000 tons of coal were won by hand in 1951—one-third less than in 1946—while, over the same period, output cut by machine rose from 142,000,000 to well over 170,000,000 tons. Experiments continued with coal ploughs and "scraper boxes," and all the armoured flexible conveyors which British or German manufacturers could provide in 1951 were put to work. By the end of last year the Board had bought 40,000 roof support bars of a new Continental pattern and had ordered 60,000 more.

Another matter mentioned in this part of the report is that, in the five years up to 1951, the number of locomotives in use underground increased from 80 to 450. By the end of last year more than 3800 large-capacity mine cars had been installed in place of the old-fashioned tubs. Furthermore, in the five years 1947 to 1951 the number of electric motors in use at collieries rose by 27 per cent. and their total horsepower by 18 per cent. On coal preparation the report says that, when the Board was set up, it took over coal cleaning plant with a capacity of 130,000,000 tons a year. Some worn-out plants have been closed, but by the end of last year there was capacity for cleaning about 143,000,000 tons a year, an increase of 10 per cent. Further plants now being built or designed, it is stated, will increase capacity by another 18 per cent.

In the chapter on carbonisation activities the report says that to maintain its coking capacity—as promised to the Government—the Board decided to build large new coking plants to replace those worn out. By 1951 plans had been made for nine new plants, and at the end of the year the total planned capacity of the plants already under construction was 3700 tons a day. Approval had also been given to build a further plant with a capacity of 5000 tons a day.

On the subject of research, the report states that the National Coal Board's aim has been to provide adequate laboratory facilities and staff for each of its areas. In the last five years thirty-one new laboratories have been built and equipped, and twelve more should be well on their way to completion by the end of the present year. A great deal of research work has been carried out into the causes and prevention of fires on conveyors, and a new material for conveyor belts is now being tried out in the pits. Other developments mentioned include a new form of rotary drill bit, a transportable coal fines washer which is undergoing trials, and some promising work in the blending of coals.

A Trailer for Bridge Testing

Owing to the considerable increase in the transport of abnormal indivisible loads of great weight, the Ministry of Transport and other authorities have been concerned about the strength and safety of the many masonry arch bridges in the country. Regulations governing the construction and use of vehicles designed to carry abnormal indivisible loads now permit maximum gross loads of 150 tons, while any single bogey having two axles can be constructed in such a way that a 45 ton load is permitted on each of the axles; the load on each wheel may be as much as 11¼ tons. Although a considerable amount of research had been done both before and during the war, it did not extend to loads of anything like the above-mentioned magnitude; thus no reliable and consistent basis exists for the calculation of bridge strength under really heavy loads, where there is filling between the arch and the road. The Ministry of Transport has accordingly undertaken a series of investigations and has purchased, and in collaboration with the Ministry of Supply, adapted an experimental test trailer, which is shown in the accompanying illustration.

It has been built entirely from second-hand and scrap material. The well deck trailer was originally built in 1929, being one of the first vehicles specifically designed for carrying abnormal loads. In the well, transverse timber sleepers have been secured, on which rest four parallel, longitudinal timber rail bearers, carrying rolled steel channels as rails. On these, four sets of Bailey bridge rocking rollers can travel from end to end of the well. The rocking rollers are made up in sets of two, each pair supporting the ends of a short transverse rocking beam, with a cylindrical bearing at its mid span. Between these bearings rests a transverse sill beam, which in turn carries the end of a massive load slab.

The other end of the slab is supported over the rear bogey of the trailer by an exactly similar but inverted arrangement of rollers, so that they remain always over the back axles, while the slab can move over them. The slab itself is 35ft long, 7ft 9in wide and 3ft thick, of solid concrete, encasing four longitudinal main steel beams. It is thus possible to move the slab to and fro in relation to the trailer, from a position in which its weight is almost equally shared by the front and rear bogeys, to one in which the weight is almost entirely concentrated on the rear bogey. The slab itself weighs 50 tons, while the trailer and fittings weigh 35 tons. Provision has also been made for adding kentledge to increase the weight of the movable slab to 80 tons.

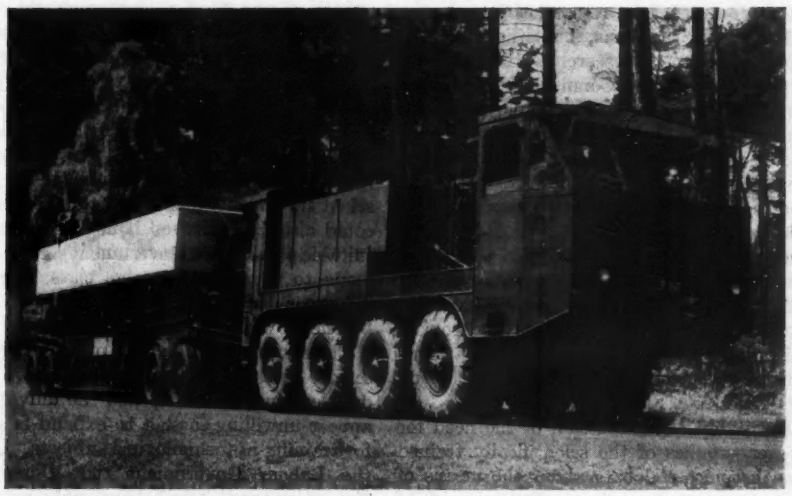
It will be possible, with these arrangements, to obtain single bogey loads ranging by small increments from 20 tons to 90 tons by moving the slab to different positions on the trailer. When the slab is in its extreme extended position, without kentledge, the front bogey weighs 20 tons, and the rear bogey weighs 65 tons. In bridge testing the procedure will be to place the front 20 ton bogey on the arch under this load and to repeat the operation with increasing loads, first under the front bogey and then, up to a maximum, under the rear bogey. As the axles of the front and rear bogeys are 25ft apart, bridges up to 50ft span can be tested readily under the effects of one bogey alone. Beyond this span, a more complicated procedure will be necessary.

The method of supporting the movable slab on rocking rollers and transverse rocking beams is intended to give articulated suspension and springing to the rigid mass on the trailer. The arrangement is very flexible, achieving uniform distribution of load throughout the structure and avoiding jarring impacts which would rapidly cause damage. In the trial runs which have now been carried out it has been found that these precautions have been successful.

Various devices have been introduced to ensure that the movable slab can be kept completely under control and secure at all times. In place of the original brakes, which were hand operated by attendants walking alongside, a system of pneumatic brakes has been introduced. Hand operated brakes have been retained for parking.

Instruments to measure the deformation of the bridges under test have been devised for use with the trailer. It was considered necessary to measure horizontal and vertical movements of the order of half a thousandth of an inch in order to reach sufficiently reliable conclusions about the strength of the bridges under test. To complicate matters further, these movements are not changes in length over short distances, but vertical deflections of the crown of the arch and variations in the span of the bridge under load.

The preparatory work of constructing the test trailer and measuring equipment has been achieved, the Ministry states, with remarkable economy in cost and materials. On the other hand, the benefits to be obtained from the series of experiments on which the Ministry, in collaboration with the Building Research Station, is embarking, will, it is hoped, be considerable.



Experimental Trailer for Bridge Testing

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SCIENTIFIC MANPOWER

EVER since it was first set up, the Advisory Council on Scientific Policy has stressed the desirability of increasing the flow of scientists to industry in this country. The fifth annual report of that body, summarised shortly in our last issue, consists almost wholly of the report of its Committee on Scientific Manpower. The need of this country for increased scientific manpower is therein reiterated. It is true that some twelve to eighteen months ago the demand for scientists, amongst whom, of course, engineers are reckoned, temporarily fell. But the coming into effect of the rearmament programme lifted it once more. Moreover, the general trend towards an increased demand is not dependent upon the temporary consequences of that programme. There are other factors that make increasing demand inevitable. In particular, if this nation is to survive as a leading industrial Power, it must, despite its ageing and no longer expanding labour force, raise its rate of output. That object can only be achieved by raising productivity; that is, by using machine power more extensively and manpower more economically; in fact, by using brains rather than brawn and by utilising to the best of their ability men who can not only conduct researches into design and technical problems, but who can also apply the results of research to the problems of production. The Committee is satisfied "that there will be useful employment for as many as are likely to be turned out in our present straitened circumstances," and "that the demand is bound to go on increasing as long as we continue to remain powerful in the affairs of the world." It is satisfied, too, that among the 93 per cent of pupils who leave school before reaching the age of seventeen and do not at present proceed to universities there are many who could profit from a university education. The reserves of talent amongst the youth of the nation are by no means yet fully drawn upon.

Inevitably any discussion of the need for greater supplies of the scientifically trained soon becomes a debate about the means of training greater numbers of them and of attracting students of high quality to the science "side." There has been much argument ever since the war about the means of providing higher technological training. Less has been said about the elementary beginnings. The Committee finds that in the grammar schools a large proportion of the pupils specialise in science, but it "finds it difficult to speak with quite the same emphasis or optimism about the public schools." Traditionally many, at least, of the older public schools favour the "humanities" as against science; and again it is probable that many parents, not trained in science themselves, consciously or unconsciously influence their children away from that type of education. "Essentially," as the report puts it, "there is an insufficient appreciation of the contribution that science makes to a liberal education, and a lack of awareness of the great opportunities for scientific and especially engineering training that are available in universities other than Oxford and Cambridge." Yet if we are to have a greater proportion of scientists in the community, as seems essential if the number of scientists is to be increased while the total population does not, then many children of non-scientific parents will need to take up science. What is needed, in fact, is a better appreciation amongst parents of the kind of living that science offers. That change would the more rapidly be brought about were it more widely realised that the highest administrative and managerial posts in industry are as open, at least amongst the larger industrial firms, to those with a scientific and technical training as to those with training of another character. The status of engineers and scientists in the esteem of the lay public could also be improved if more transfers of suitable scientists in Government service were made to the administrative class, a policy recommended in the Barlow Report of 1943, but never at all fully implemented.

The number of students of pure and applied science at British universities has more than doubled since the war; and the universities appear unwilling further to expand facilities for training in technological subjects. Under the Labour Government the Ministry of Education produced a scheme whereby a still further increase in the number of technologically trained men would be secured by the selection of a few technical colleges for special development to provide courses different in content from, but of a standard as high as, a degree course. The Committee remarks upon that proposal that it "could only offer a partial solution to the problem . . . What is clearly needed as well is the further expansion of facilities for scientific education in the universities." For our part, and thinking in particular of the training of engineers, we fully agree. At present the relative numbers of students of arts and science at British universities remain much the same as before the war. We believe the universities desire not to change that balance. Yet ours is an age in which science is playing a larger and larger part in moulding civilisation. We believe universities to be the best places for the training of engineers if only because the narrowing effect upon the mind of that specialised training needs to be counteracted by contact with students of other faculties. Nor do we believe that students of other faculties would come to any harm were the scientific activities of universities to be expanded. For just as the scientifically trained individual is not well fitted for administrative and managerial posts if he has had no contact with the arts and "humanities," so, too, is the arts graduate ill-fitted to such posts in Government service or in industry without an appreciation of science and the scientific method. There are not two sharply differentiated sides to modern life, in science and in art, between which to choose. The two are intermingled. Only those who in maturity have an appreciation of both, even though specialising towards one, can be capable of the enlightened judgment required of a good administrator or a high executive.

ANTI-SUBMARINE WARFARE

THERE are three main problems to be solved in anti-submarine warfare. The submarine has first to be detected; contact with her has then to be maintained until she can be attacked, and the weapons required for her destruction have to be effectively controlled and correctly aimed. Before the last war a submarine operated primarily on the surface, only submerging when necessary to avoid being sighted. But the coming of radar, which can detect a surfaced submarine at a considerable distance, forced the U-boats to adopt the schnorkel. In the latter part of the war they remained submerged from the time of leaving harbour until the completion of their patrol, some six to eight weeks later. But to-day a submarine on passage and using her snort can no longer feel safe from detection. Improvements in radar during the past few years have made it possible to detect the snort tube in a reasonably calm sea at an effective distance—according to reports from America—of 8 miles, thus restoring to aircraft some of the great value they had in World War II for convoy escort work. Helicopters, which can be operated from merchant ship platforms, should be particularly useful as air patrols. With their ability to hover over a suspected target they will drop sono-buoys to fix the submarine's position and summon escort vessels or aircraft to effect her destruction. Finally, if and when the submarine attempts to

press home her attack to close range, she is likely to be detected by the asdic installation of the escort vessels. But with "homing" torpedoes which are steered towards the target by the sound of propellers, a close-range attack may no longer be essential for success.

It is not enough to be able to detect the presence of a submarine. Contact must be maintained when she has been detected and is trying to get away. The modern submarine, with large batteries, can maintain a submerged speed of 17 to 19 knots for about an hour, speeds which are too fast for our wartime frigates to chase the submarine and much too fast for them to destroy her. For the tactics used in attacking a submerged submarine require the surface vessels to have a considerable excess of speed, and as newer types of submarine now under construction are credited with an underwater speed of 25 knots, it is clearly of urgent importance that the Western Nations should build a large number of fast anti-submarine vessels, with a speed of not less than 30 knots, with the minimum possible delay. A good beginning—but only a beginning—has been made under the rearmament programme with the laying down of twenty-four fast frigates and the conversion to fast frigates of forty-five of our existing destroyers. It is also essential that the asdic installation in surface ships should operate efficiently at these high speeds. Strict secrecy is maintained on asdic development, but it is known that considerable progress has been made and there can be little doubt that modern sets work efficiently at speeds much in excess of the maximum wartime speed of 18 knots. For killing a submarine, the weapons and missiles now available to anti-submarine forces are depth charges, depth bombs, projector charges, "homing" torpedoes and rockets. Another improvement introduced since the war is an effective fire-control system for firing depth charges and other short-range weapons. Formerly as the surface vessel reached a position close to the submarine, asdic contact was lost just when it was particularly necessary to maintain her range and bearing. The firing ship thus required other vessels to maintain contact while she was doing the killing. The new system of control links up with asdic contact and pinpoints the submerged target up to the time of firing. Improved hydrostatic fuses have also been introduced to give greater depth settings and thus increase the probability of a kill. Another anti-submarine weapon developed in the last war is the "hedge-hog"—a mortar type projector mount which fired a projectile fitted with a contact fuse and had a range of less than 1000 yards. One or two of these projectors were installed in the forward part of a surface ship and classified as "ahead-thrown weapons," to distinguish them from depth charge throwers in the stern of the ship. Since the war the projector has been much improved, training and control gear has been incorporated and the firing charge has been increased to obtain greater range. The missile now has also greater sinking speed and a more efficient fuse. Great hopes too, are placed on the "homing" torpedo—operating on the acoustic system—as an anti-submarine weapon.

But probably the most radical advance in underseas warfare since the war is the development of a new rocket launcher for use in surface ships. It fires a relatively large rocket with a heavy explosive charge with a range considerably in excess of 1000 yards. The equipment, which has already been installed in some ships of the United States Navy, incorporates an efficient system of fire control. Mention must be made also of "hunter-killer" groups which are organised to seek out and destroy submarines lying in wait on the ocean shipping routes. Each group normally consists of a carrier with her embarked aircraft carrying the submarine detection equipment described above, and from four to six destroyers or other anti-submarine vessels. With the possibility of being detected by a "hunter-killer" group at any time and in any area, the submarine has to be constantly on the *qui vive*. Her only opportunity for a rest is to dive deep, below schnorkel depth. But she loses then all chance of receiving convoy interception reports from reconnaissance aircraft and of picking up convoys, approaching her patrol area, on her own radar. Providing there are sufficient "hunter-killer" groups at sea and adequate numbers of fast frigates available, the life of a submarine in the next war will certainly be hazardous. But the proviso is important. If there are not it will not be the submarine, but the sea-borne supplies to this country, which will be destroyed.

Literature

Earth Dams (*Les Barrages en Terre*). By CH. MALLET and J. PACQUANT. Paris: Editions Eyrolles, 61, Boulevard Saint-Germain, Paris (V). Price 2500 francs.

THERE is reason enough to believe that from among all civil engineering works, the earthen dam is, very probably, the oldest; for it has been used since time immemorial in various countries where irrigation has been practised on a national scale, such as India, Ceylon, Egypt, &c. For instance, the construction of the 100ft high and 500ft wide Cumman dam, in Madras province, dates back to an early era of Hindu history, while some of the earthen banks, which control basin irrigation on the left bank of the Nile, are believed to have been built under the Pharaohs. Curiously enough, the earthen dam is also the type, the design and construction of which have achieved the greatest progress—in fact, almost revolutionary progress—in the last two or three decades. The origin of this revolution may possibly be traced to Krey's circle, which, in 1912, was suggested to replace Coulomb's and Rankine's plane of sliding. Thereafter followed the investigations of Petterson, the report of the Swedish Committee, the methods of Professor Terzaghi, Fellenius, Rendulic, Chugaev, Ivanov, and many others. At the Second Congress on Large Dams, held in 1936 in Washington, this revolution in thought reached its climax, for the papers read and discussed before it fully reflected the new turn in the ideas on the subject. To gauge the extent and the scope of the advance made during this period in earthen-dam design, theory and practice, it will suffice to oppose the traditional routine presented in the relevant publications of the nineteen twenties,* to the methods of this new book dealing with the subject.

This new volume must particularly appeal to those who have read, enjoyed and profited by Terzaghi and Peck's *Soil Mechanics in Engineering Practice*, for the basic approach is very much the same in both works. In fact, Professor Terzaghi has contributed a short preface to the new book, and his remarks on various points of its text are appended at the end of the volume.

After a short introductory chapter containing among other information a list of forty-two destroyed earthen dams (period 1842 to 1938), giving the reasons for the failures, the authors have included a well planned, though not an exhaustive, chapter on estimating and providing for the maximum discharge, illustrated by examples selected chiefly from the latest practice in North Africa. Thereafter follow chapters on percolation and piping, on stability calculations, and on the choice of materials and execution of the work. The chapter on percolation, containing as it does over a hundred pages, is particularly well presented. It might, however, have been made more comprehensive if in addition to A. Casagrande's method for tracing the saturation curve, Professor Dachler's solution of the same problem had also been included. On the other hand, although some of the latest graphical methods for flow-net diagrams are quoted in the list of references, at the end of the volume, they are neither explained nor referred to in the text. The chapter on stability opens up with the usual references to Mohr's criterion of failure and to Rankine's passive and active states, characteristic of the latest publications of Professor Terzaghi's group, but contains also references to less well-known French methods, and a rather large amount of material taken from the proceedings of the Washington Congress of 1936. For instance, the section dealing with the effect of percolation on the stability of slopes, reproduces almost literally the report of Mr. R. R. Chugaev, to that congress (Vol. IV, page 593 of the *Proceedings of the Congress*). The last chapter dealing with the practical problems of modern earth-dam technique, contains useful information based chiefly on American practice, but is rather more concise than the theoretical chapters.

The book is a welcome addition to a civil engineering designer's library.

Steels in Modern Industry: A Comprehensive Survey by Twenty-nine Specialist Contributors. General Editor, W. E. BENBOW. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 42s.

THIS book is written primarily for the engineering user and designer. It aims to survey in an assimilable and compact form the results of recent research and development in ferrous metallurgy and to discuss these results in relation to their actual and potential engineering applications. This it does in a series of related critical reviews prepared by a team of specialists, each of whom is an authority in his field.

A general metallurgical introduction is followed by a series of articles on "General Properties Influencing Engineering Design." This section includes the consideration of wear and mechanical properties, fatigue, creep, corrosion, scaling resistance, weldability, and machinability. The next section deals with "Specific User Aspects" and presents short accounts of present-day achievements and practice in structural engineering, aircraft and automobile engine steels, gas turbine steels and alloys, steels for steam turbines, boilers and piping, pressure

* E.g., Justin's paper on "The Design of Earth Dams," published in the *Transactions of the American Society of Civil Engineers*, in 1924, or the 1st Volume of Ziegler's *Der Talsperrenbau* Berlin, 1925.

vessels, steels for the chemical industry, tools and dies, cold pressing, high permeability alloys, permanent magnets, permalloys, and non-magnetic steels and cast irons. A final section discusses "Surface Treatments" and reviews protective treatment, nitriding, carburising, flame and induction methods of surface hardening, and shot peening.

The list of contributors is certainly imposing and, as would be expected, the reviews are of a high standard, some of them exceptionally so. The book is not a mere compendium of design data and succeeds in its main objective of reviewing critically the application of recent developments in ferrous metallurgy to various fields of engineering. Perhaps the most serious criticism is that, contrary to the promise made in the foreword, a few of the articles are not accompanied by a selected list of references for the use of readers wishing to refer in more detail to the available literature, and in some other sections the list of references provided might be considered inadequate. It is to be hoped that this will be remedied in future editions, as an adequate bibliography adds materially to the value of a critical review. The section on structural engineering might usefully be expanded, while the engineer seeking information on alloy conservation, alternative steel specifications and an authoritative statement of British and American views on boron steels will be disappointed.

In a book of this length, to which so many authors have contributed, it is not surprising that there are some editorial inconsistencies. Many of them are trivial, but perhaps the most important is the omission of a key to the sixteen lettered curves in Fig. 1 on page 485. The accompanying text states that this figure is reproduced from a paper by Lozinsky in the *Journal I.E.E.*, and it is a further source of irritation to the reader that this is not so. It is actually reproduced from Fig. 2 on page 53 of Lozinsky's paper in *Vestnik Metallopromyshlennosti*, 1940, No. 3. In the comments on steel En2A on page 337 it is stated that the carbon content of this steel is limited to 0·012 per cent. This is obviously a misprint for 0·12 per cent, but it is unfortunate that this follows so closely on the explanation that the comments are designed to be of help to those who are unfamiliar with the steels concerned.

There are also some points to which the purist might take objection. Examples are the statement on page 5 that "In the Thomas process the large phosphorus content is essential, the reaction between the phosphorus and the slag by which dephosphorisation of the steel is effected serving to provide a considerable quantity of heat"; the reference on page 277 and Fig. 16 to DW quality steel as "mild steel"; and the lavish use of quotes for such words as ferritic, austenitic, sigma and creep, in the section on "Scaling Resistance."

The text is attractively presented and the line diagrams are exceptionally clear and informative, although some of the photographs have lost detail in reproduction. There is a comprehensive forty-page subject index and a six-page author index.

This useful book of refereñce will appeal to the engineering user and designer and many industrial metallurgists will find the reviews interesting and refreshing.

Thermodynamics of Fluid Flow. By NEWMAN A. HALL. New York: Prentice-Hall, Inc., 70, Fifth Avenue, New York City. 1951. Price 7·65 dollars.

THE advent of the gas turbine as an important prime mover and the development of continuous combustion systems for other purposes has aroused considerable interest in the application of thermodynamics to flow processes. It has become of great importance to give a unified treatment of subjects previously treated separately—thermodynamics and fluid flow. In the preface of the present book, tribute is paid to Stodola for his pioneer work in the application of analytical methods to engineering problems. The present book is essentially a theoretical treatment. The analysis is restricted to steady unidimensional flow applied to perfect gases, with extensions to liquids and imperfect gases. Units and dimensions are carefully discussed, a six-unit system is adopted throughout the text. The characteristics of fluids are reviewed with emphasis on the transport properties; the reader is guided to reliable sources of basic data, such as the recent compilation of selected values for the properties of hydrocarbons by the National Bureau of Standards.

Fluid friction is considered from the semi-theoretical treatment of Von Karman with reference to recent extensions. Flow losses for various obstructions are presented as internal drag coefficients. The basic energy and momentum equations are developed in logical sequence for steady flow. Tables of functions for state variations along Fanno lines are appended for analysis of losses in constant area adiabatic flow up to Mach numbers of 10. A discussion of shock fronts leads into a discussion of convergent-divergent nozzles following closely Stodola's analysis.

Flow with heat exchange, in the text denoted as "diabatic" flow, is given justifiable prominence. Rayleigh line functions are given graphically with examples of their application. Thermal discontinuities are briefly discussed with demonstration of deflagration and detonation processes. Brief analyses of practical propulsion systems are given as worked examples of the earlier theoretical treatment.

The book presents a clear and careful statement of the essential theoretical background to the thermodynamics of flow processes and goes some way in covering the difficulties of applying the theoretical material to practical cases. The text is clearly and carefully set out; it should fill a real need among advanced students and engineers seeking an insight into this important subject.

SHORT NOTICES

Irrigation Engineering. Volume I: Agricultural and Hydrological Phases. By I. E. Houk. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 72s.—The author, who is a consulting engineer in Denver, Colorado, has divided the subject of irrigation engineering into two parts, namely, agricultural and hydrological phases, and project planning and structures, the first of which is considered in this volume. He states that very few books on this subject have appeared recently and this volume is an attempt to bring the subject up to date.

Some historical notes are given at the beginning of the volume, followed by several chapters on soils, as they affect the irrigation engineer, from the points of view of fertility and moisture. A review of climatic considerations leads to chapters concerned with rainfall, run-off, evaporation, snow melting and run-off forecasting, land evaporation and transpiration. These chapters are followed by a study of the actual requirements of water for irrigation, as influenced by crops, wastage, sources of supply and the quality of irrigation water. Lastly, there are chapters on the irrigation of saline and alkali soils, and on the preparation and procedures for irrigation. Most of the discussions in the volume relate to conditions in the west of the U.S.A., and attention is given to advances made during the past few years.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

GEAR DESIGN AND BRITISH STANDARD 436

SIR,—I feel moved to comment on certain points in Mr. Welbourn's interesting article on this subject.

Whilst the B.S. 436 formulæ for load capacity of gears can be criticised for departing rather seriously in certain ways from rationality, they are not, in my opinion, difficult to apply to gears of any specified dimensions. The standard says nothing, however, about the converse problem which is that of determining gear dimensions for a specified duty, and perhaps it is in this respect that Mr. Welbourn asks for improvement. It would be easy to compress working rules for solving the design problem into a short article, but not everyone agrees that it is suitable subject matter for a British Standard. In the meantime it may be useful to state that for given materials, diameters and width, load capacity based on surface stress is unaffected by change in numbers of teeth, but that load capacity based on bending stress is roughly proportional to the pitch of the teeth. For geometrically similar gears the load capacity is proportional to the 2·8th power of the linear dimensions. The B.S. zone factors for spur gears are at present based on the carrying of the full load on one tooth in each gear in certain phases of engagement.

In the current revision of B.S. 721 (Wormgears) the use of a load capacity formula on the general lines suggested by Mr. Welbourn is under discussion and the same matter will doubtless be considered when B.S. 436 is revised.

Scuffing is the visible consequence of a failure of the lubricant and is not taken into account in the B.S. load capacity formulæ for gears. The assumption is that the gears will be lubricated by an oil capable of withstanding the loading conditions and as such an oil can always be found, the assumption is a reasonable one. Where scuffing occurs in practice, it is the result either of local concentrations of surface stress resulting from imperfections in cutting or mounting of the gears, or of the use of an oil inadequate for the nominal loading conditions. This latter case may arise where an attempt is being made to apply the same oil to different purposes within the plant of which the gearing forms a part.

Whilst the B.S. formulæ for load capacity of gears may be replaced by others more nearly rational, it is too much to hope that they will at the same time be simpler, as the present ones involve no superfluous factor.

W. A. TUPLIN
Professor of Applied Mechanics.

Sheffield, 1, May 30th.

BOOKS RECEIVED

Werkstattbucher: Langen Messungen. By Hans Schmidt. Berlin: Springer-Verlag, Berlin. Price 3.60 Dmk.

Pipe Resistance. By T. E. Beacham. London: E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 18s.

Electrical Year Book, 1952. Manchester: Emmott and Co., Ltd., 31, King Street West. Price 3s.

Principles of Lighting. By W. R. Stevens. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 35s.

Electrical Instruments and Measurements. By W. Alexander. London: Cleaver Hume Press, Ltd., 42A, South Audley Street, W.1. Price 12s. 6d.

Servo-Mechanisms. Vol. 5. Department of Scientific and Industrial Research. London: Her Majesty's Stationery Office, York House, Kingsway, W.C.2. Price 63s.

Prophecy and Achievement in Aeronautics

By SIR HARRY M. GARNER, M.A., F.R.Ae.S.*

No. I

In this Wilbur Wright lecture, presented to the Royal Aeronautical Society on May 29th the author begins by tracing some major developments in aeronautical design and indicates where and in what manner certain early predictions dealing with ultimate size and speed of aircraft had been falsely conceived. The author then discusses two major discontinuities in that development, which conclude this part of the abstract, the first being related to the advent of the monoplane and the second discontinuity arising with the availability of jet propulsion.

THINKING of the great achievement that this Wilbur Wright Memorial Lecture celebrates, it is not surprising that many previous lecturers have taken the opportunity of surveying the progress made since the pioneering days of 1903. Some of them have looked into the future and have predicted good progress, but none of them has foretold the rapid progress that has actually taken place. The reason for this is simple. Forecasts were necessarily made on the basis of existing knowledge and no account was taken —nor could it be—of entirely new ideas which were destined to lead to great advances in aircraft design.

There have been a number of occasions in the history of aeronautics when it seemed that progress was coming to a standstill. Engineers and scientists of outstanding ability have come forward with suggestions that the end of development in one direction or another was being reached. Their fears have afterwards proved to have been unfounded. The examples I shall give will not, I am sure, be thought to cast any slur on these great men, whose contributions to progress in aeronautics have been outstanding. Looking at a simple record of the performance of aircraft during the past forty years or so, for example, a record of aircraft speeds, it is generally found that a simple curve has been drawn through a set of scattered points, suggesting that progress has been smooth and continuous. In fact, progress results from two causes: first, the gradual improvement in knowledge of materials, structures, aerodynamics and engine design; and secondly, inventions that make radical alterations to the design of the aeroplane. Examples of these inventions are the unbraced monoplane and the turbine engine. Neither of these could have been produced without the development of new materials capable of taking high stresses, and in fact it is the steady building up of scientific knowledge that makes a major invention possible. This building up of knowledge has been described by Sir Ben Lockspeiser as "scientific capital." Without it aeronautical engineering, and in fact all engineering, would soon stagnate.

The development of civilisation generally has proceeded in this way. The invention of the wheel must have provided a major discontinuity in the development of transport. The arrow, which allowed fighting to take place at a distance instead of hand-to-hand, was an invention that produced a major change in methods of warfare. The achievement of steady flight of the arrow must have required some careful aerodynamic experiments in which the effects of change in the centre of gravity and fin area were no doubt thoroughly tested before an efficient arrow was produced. In Nature itself progress has taken place by means of distinct mutations. These, compared with the inventions of man, have been slow, and millions of years have generally been needed to produce substantial changes. As an example the horse has been developed from an animal the size of a large terrier, during a period of fifty million years, to become the much larger and faster animal of to-day.

A number of discontinuities, major and minor, will be found in examining the progress of aeronautical design through the past fifty years. One of the earliest problems that engaged the speculation of scientists in aeronautics was that of the so-called "square-cube" law. The weight of similar structures increases as the cube of their linear dimensions, while the load-bearing capacity increases as the square. Thus a structure becomes steadily weaker as the size increases. This is the law that limits the size of land animals. The legs of a deer are much thicker in proportion than those of an insect and the legs of an elephant much thicker still The elephant is about the limiting size for a land animal. Larger animals are compelled for structural reasons to become amphibious, such as the prehistoric brontosaurus, or aquatic, such as the whale.

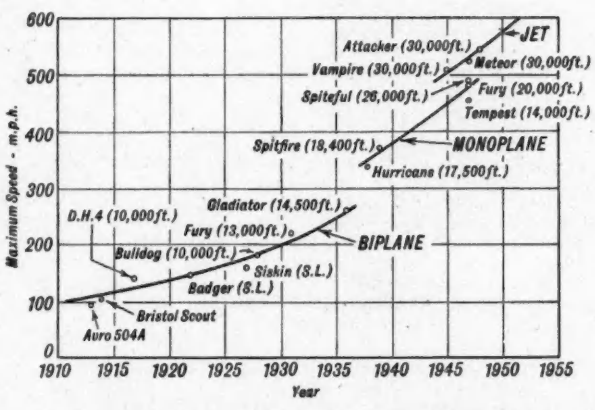
The early designers of aircraft were only just able to design aircraft that would lift their own weight, with that of the pilot and sufficient petrol to last for a short flight, and it is not surprising that they were pessimistic about the design of larger aircraft. In the early days a number of theories were put forward on the limitations of weight and size of aircraft. In 1912, in a discussion before the Royal Aeronautical Society, A. R. Low suggested that the limiting all-up weight of an aeroplane would be a little over 2000 lb.

Lanchester, in his James Forrest Lecture of 1914, was more cautious, but he did express the view that a span of about 100ft was the best value for economic flight. Southwell, in the Forrest Lecture of 1930, however, pointed out that Lanchester's predictions were sound except for his view on the weight of engines. I shall return to this point later.

It remained for Durand in his Wilbur Wright Lecture of 1918 on "Outstanding Problems in Aeronautics" to put the square-cube law in the right perspective. After pointing out that a large aeroplane need not be an exact scale copy of a small one, in that the details of design could be more refined, went on to say: "In short, then, so far as increase in size is concerned, there seems no reason to apprehend any particular limit or any serious difficulty on the part of the scientist and engineer meeting the demands of the future." Anyone asked to give a limiting weight to-day would say that under present conditions the limit would be about 1,000,000 lb. The reasons for the tremendous increase that has taken place, even since 1918, are many. Farren in his Wright Brothers Lecture of 1943, makes a detailed comparison between the biplane Handley Page "0/400," the largest bomber of the first world war, and the monoplane "Lancaster," the most successful British bomber of the second world war. He finds a large reduction in structural weight in spite of increased complexity through the introduction of retractable undercarriages, flaps, wheel brakes and other devices. Marked improvements in engine design, which enabled an increase of 70 per cent to be made in the ratio of power to weight, in spite of the addition of superchargers and constant-speed propellers, were also a major factor.

The reduction of structural weight was mainly caused by better distribution of the component masses along the wings and body, improvements in materials and increases in wing loadings. Improvements in materials have had a large effect both on airframes and engines. The strength of aluminium alloys increased from a maximum stress of 5 tons per square inch in 1900 to 25 tons per square inch in the first world war and to 30 tons per square inch in the second, with possibilities of 40 tons per square inch to-day. More significant still is the increase in proof stress from 15 tons per square inch in the first world war to nearly double that value to-day. Increases in wing loadings, made possible by the provision of long concrete runways suitable for high take-off and landing speeds and the use of high-lift flaps, have made a greater contribution to improvements in aircraft than any other factor. The wing loading of the "Lancaster" was 50 lb per square foot, as compared with 8 lb per square foot for the Handley Page "0/400" and 1½ lb per square foot for the Wright Brothers aeroplane in 1903. Wing loadings to-day for bomber and transport aircraft may be as high as 100 lb. per square foot with landing speeds of 150 m.p.h. or higher. These values would have seemed fantastic to the early designers. I think that it is doubtful whether an aircraft designer to-day could make a great improvement on the Wright Brothers' aeroplane if he were limited to the same stalling speed and the materials available in 1903.

Thus the difficulties of the square-cube law have been evaded, rather than overcome, by



MAXIMUM SPEEDS OF FIGHTER AIRCRAFT

*Chief Scientist, Ministry of Supply.

not adhering to geometric similarity. A comparison of the Saunders Roe "Princess" with the "Felixstowe Fury," designed in 1917, is given in Table I.

TABLE I

	Weight, lb	Wing loading, lb/sq ft	Wing area, sq ft
"Felixstowe Fury"	28,000	9	3,108
"Princess"	315,000	63	5,000

The increase in wing loadings, combined with the improvement of materials, finally decided the vexed question of monoplane versus biplane that had been argued for years by aircraft designers. Even as late as 1929 convincing reasons were put forward in favour of the biplane.

The achievement of high speed is the quality in which the aeroplane is ahead of all other forms of transport. It owes its advantage, not to its increased efficiency—the efficiency is far lower than that of the various forms of land transport—but to the smoothness and ease of travel in three dimensions as compared with travel in two dimensions. At all stages the achievements in speed have outstripped the prophecies of the experts. Lanchester, in 1914, said: "A maximum flight speed . . . of about 120 m.p.h. is one for which it is already possible to design, though it is likely that some years will elapse before speeds materially in excess of this will be reached." Ten years later this speed was more than doubled. In 1923 Glauert and McKinnon Wood made a close examination of the speeds of racing aeroplanes. They concluded that "the highest speed attainable with the present type of engine is a little over 300 m.p.h. when the stalling speed does not exceed 75 m.p.h."

The qualification on the stalling speed is important, and this report seems to have been the first to draw attention to the significance of the speed range, the ratio of the top speed to stalling speed. The value of 4 to 1 was one that most aircraft designers would have been happy to achieve for some years after that report was written. To-day improvements in wing sections, the use of high-lift devices to give lower stalling speeds, and the development of engines with much higher thrusts for a given cross-sectional area, have enabled ratios of 5 to 1 and higher to be obtained. But the main increase in top speed has been achieved, as the report clearly foresaw, by increases in wing loading, which have led to higher take-off and landing speeds.

Speed records for aircraft have always been confined to flights near the ground. Now that flights at and beyond the speed of sound are possible the advantage of flying near the ground disappears. Because of the higher density of the air near the ground the structural loads are higher and the effect of gusts, even on the calmest day, makes flying extremely dangerous.

In the curve of maximum speeds of fighter aircraft, shown on page 767, the speeds are those obtained at the operational height of the aircraft. The heights start, with the early aircraft, at 10,000ft or lower and go up to 30,000ft or higher for modern aircraft. In these curves I have shown two major discontinuities, one of which took place round about 1935 and the other round about 1945. The first was the result of great changes in shape and structure and the second of the introduction of the gas turbine.

The change to monoplanes led to an advance in structural and aerodynamic design probably more important than at any other stage in aeronautical development. The possibilities resulting from cleanness of design had already, in 1929, been put forward by Melvill Jones and were fully appreciated by designers. The cleanness of skin-covered metal wings and fuselages emphasised the high drag of exposed undercarriages and the structural complexity of retractable undercarriages was seen to be worth while. Attention was concentrated on those parts of the aeroplane which gave high drag, such as bad nacelle fairings and windscreens. The introduction of flaps led to a reduction in wing area and to still lower drag. Thus the introduction of monoplanes, in concentrating attention on the importance of the reduction of drag, had a far-reaching effect on the whole design. The effect is shown by the distinct gap in the curve.

The second break was the result of the invention of the gas turbine and particularly of the turbo-jet. The turbo-jet gives a high thrust for its weight and cross-sectional area and does not need the elaborate separate cooling systems of the piston engine, which create additional drag. But apart from these direct advantages, the abolition of the propeller has been of great value in removing a source of disturbance of the flow over the wings and its attendant drag, and in removing a source of instability, caused by the forward fin effect of the propeller which has to be balanced by increased fin area at the rear. I think that these secondary advantages have not even to-day been fully appreciated.

No one is likely to-day to underestimate the effect of improvements in engine design on aeronautical progress. To the early designers the production of an engine with a low weight for a given power was perhaps the most formidable problem. Although other factors than weight are important to-day, a low weight to power ratio is still one of the most important factors in engine design. The prospects did not seem very hopeful to Lanchester in 1914; in his James Forrest Lecture he said: "It is difficult to believe that any great reduction of weight per horsepower can be effected on the best figures available to-day without any sacrifice of reliability." The reliability of engines to-day is of a much higher order than that thought sufficient in 1914 and the weights per horsepower of the largest engines are about one-third of the values Lanchester had in mind.

(To be continued)

International Conference on Large Electric Systems

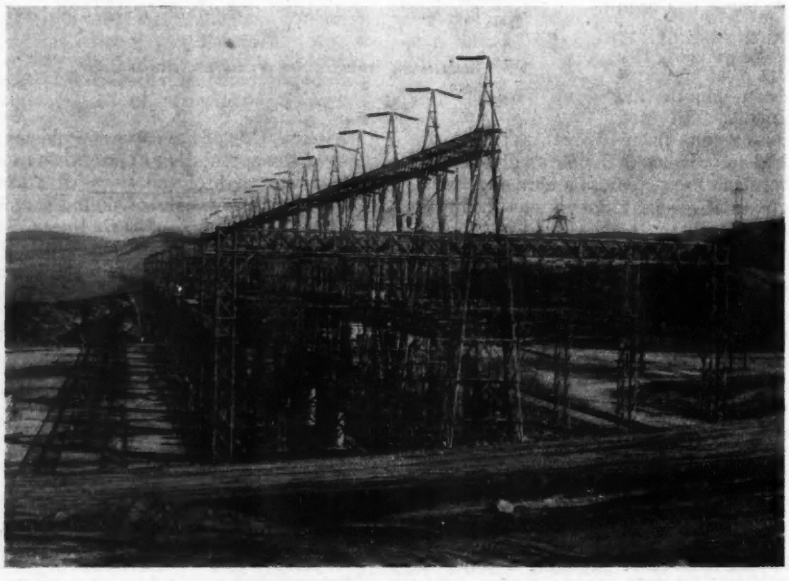
No. II—*(Continued from page 727, May 30th)*

The fourteenth biennial meeting of the Conference Internationale des Grands Reseaux Electriques (C.I.G.R.E.) is being held in Paris from May 28th to June 7th. This conference was founded in March, 1921, under the ægis of the International Electrotechnical Commission and its purpose is to assist technical progress in high-tension electric systems by meeting for discussion every two years. Between the biennial conferences continuity is maintained by seventeen international study committees. The 1950 conference was attended by 1252 delegates representing forty-two countries.

Circuit Breakers

CIRCUIT breakers were discussed on Thursday afternoon and Friday morning last week, the papers being divided into five groups.

The first group dealt with the natural frequency and the amplitude factor of the recovery voltage in system networks or at testing station. Some results of such measurements were given in a paper (No. 109) by R. Belot (Belgium) and another paper (No. 102) by J. S. Cliff (A.S.T.A., Great Britain). Belot's paper carried a stage further the results of previous tests made on the networks of the Unions des Centrales Electriques du Hainault (given in Paper No. 317 of 1950) and contained data about the amplitude of recovery voltage and the natural frequencies, based on short circuit tests on the station busbars. Cliff's

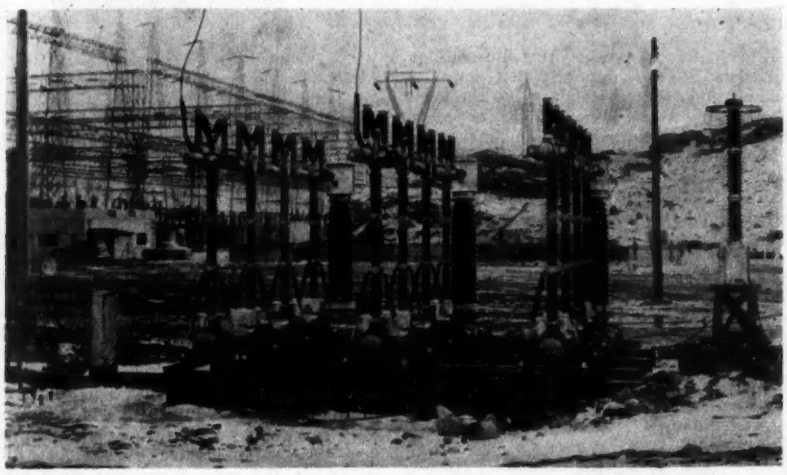


GRAND COULEE SWITCHING STATION

paper completed the data on restriking voltage submitted at the 1950 conference by giving data on the restriking voltage amplitude factors* obtained at the circuit breaker testing stations of the Association of Short Circuit Testing Authorities.

This group of papers also included a survey (No. 104) by O. S. Johansen, of the calculated values of the rate of rise of restriking voltage and of the amplitude factor in the Swedish networks. By making these calculations for a number of points in the networks the author was able, on a statistical basis, to suggest suitable reference values for the rate of rise (r.r.r.v.) and natural frequency.

Similar investigations made with the help of a network analyser, on the British 132kV grid, formed the subject of a paper (No. 120) by L. Grosland and J. S. Vosper (Electrical Research Association). The results of this survey, to date, suggest that rates of rise up to 7·5kV per microsecond at amplitude factors up to 1·7 can exist at about 400MVA. Rates of rise of about 4kV per microsecond exist up to about 50 per cent of the total short circuit MVA on any one busbar. Future



AIR BLAST CIRCUIT BREAKER ON TEST AT GRAND COULEE

system developments may be associated with similar rates of rise at 80 per cent of the total MVA. Amplitude factors, in the cases studied by the authors ranged from 1·2 to 1·8. The authors' conclusions indicate that, at present rates of rise at maximum MVA values for a given busbar are usually less than 1kV per microsecond with amplitude factors up to 1·8, although rather higher rates may be expected in extreme cases in the future.

The discussion evoked by this group of papers showed that there is considerable difference of opinion about the need for and, indeed, the feasibility of international agreement on the values of r.r.r.v. and amplitude factor. Professor G. de Zoeten (K.E.M.A., Holland) thought there was need for such agreement, taking account of data obtained from various networks. He suggested that agreement should be possible concerning the values under the most unfavourable conditions that could arise in practice. He felt that the whole subject was worthy of study by a C.I.G.R.E. committee.

On the other hand, W. A. McNeill (Cooke and Ferguson, Great Britain) expressed doubts about the desirability of attempting to correlate values of reference and amplitude factors, bearing in mind that those values could only be related to a limited number of cases. The effect of the widely differing network conditions that applied in different countries was emphasised by L. Grosland (discussing Johansen's paper). He said that very different values of r.r.r.v. from those given in his own paper would be given if one applied Johansen's formula to the British 132kV grid. The discrepancy was inevitable because of the essential differences between the British network, with its high density of supply points, and the Swedish system with its very long lines and widely separated supply points.

C. H. Lackey (Reyrolle, Great Britain) referred to Grosland and Vosper's introduction of the network analyser as a tool for obtaining values of r.r.r.v. and he thought that such a method was better than that of applying fault tests. Referring to the difficulties of standardisation he pointed out that Continental manufacturers usually quoted lower r.r.r.v. values than those given by British and American firms. He asked what circuit conditions should be chosen for the purpose of correlating such measurements and calculations, and what assumptions should be made about the length of connected lines, damping factors and other variables.

Another group of papers was concerned with the over voltages associated with the operation of circuit breakers. In the first paper (No. 101) J. R. Mortlock and M. M. Jones (B.T.H., Great Britain) dealt with a method of calculating the values of linear resistors connected across the breaks of a.c. circuit breakers. A paper (No. 114) by R. Pichard (Zurich) gave a comparison of over-voltages resulting from switching an open line fed by a transformer, the neutral being alternatively earthed and insulated. In the third paper (No. 115) Hans Meyer (Brown Boveri, Switzerland) published the results of field tests conducted on a new design of air blast circuit breaker with series breaks and shunt resistors. The fourth paper (No. 131) in this group was given by J. Saint-Germain and Monsieur Perolini (Societé Alsthom, France); the authors made an oscillographic study of the over-voltages produced by the interruption of magnetising currents and suggested that these voltages should be limited by connecting surge diverters to the transformer terminals.

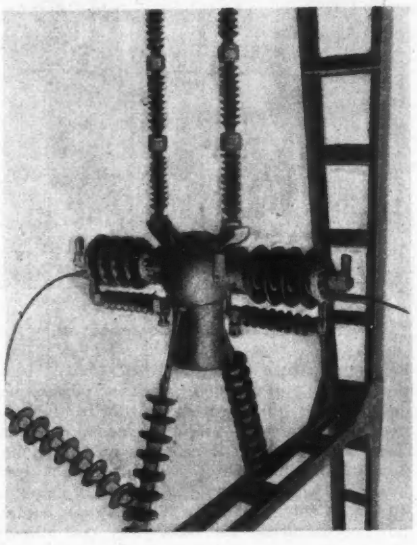
In the discussion on this group of papers D. F. Amer (Reyrolle, Great Britain) gave details of tests on the interruption of transformer magnetising currents by 132kV circuit breakers rated at 5000MVA and 2500MVA, which limited the over-voltages to less than the flashover value of a 26in rod gap. Likewise, no serious over-voltages were produced during tests on 132kV circuit breakers interrupting the line charging current of 7 miles of cable and 200 miles of overhead line. C. H. Lackey (Reyrolle, Great Britain) drew attention to the necessity for taking account of the damping effect of shunt reactors, &c., in making tests on the interruption of magnetising currents.

J. S. Cliff (G.E.C., Great Britain), discussing the paper by Saint-Germain and Perolini, emphasised the importance of distinguishing between over-voltages associated with circuit breaker operation and those caused by high voltage fuses. He maintained that it was desirable to determine the characteristics of fuses, rather than to accept over-voltage values appropriate to circuit breakers. He gave the following proposed figures for the nominal and over-voltage (peak) values in kilovolts: 3·3/20, 4/45, 15/60, 33/120, 66/185, 132/315, with the proviso that those values were probably on the conservative side.

In the next group there was a paper (No. 130) by J. Teszner and A. Guillaume (F.A.C.E. de Jeumont), P. Fourmarier (University of Liége) and J. Blase and P. Walch (A.C.E. de Charleroi) on the currents that flow in the arcing chamber after the extinction of the arc. In this paper the authors described a special shunt designed for the measurement of these post-arc currents and presented a number of oscillograms made with the help of this shunt.

Tests for proving the guaranteed rupturing capacity of circuit breakers were the subject of the fourth group, represented by a paper (No. 137), in which Wanger and Killgore gave an interesting account of field tests made in the U.S.A. on the Grand Coulee Power Plant. The short circuit capacity of 7850MVA (symmetrical) and 10,500MVA (unsymmetrical) provided by this power system was used to test a 230kV air-blast Brown-Boveri circuit breaker. Views of the Grand Coulee switchyard and of the 230kV breaker, with its control cabinet on the left, are reproduced herewith.

In the discussion of this paper, S. E. Schultz (Bonneville Power Administration, U.S.A.) outlined the need on large power systems for circuit breakers with rupturing capacities of 10,000MVA, with rapid reclosing (in the order of 0·15 sec), and with a minimum of oil or, better still, no oil whatever. A. J. Gibbons (British Electricity Authority) drew attention to the fact that the capacity of testing plants was becoming inadequate for the proving of large high-voltage circuit breakers. He made a plea for greater co-operation between manufacturers and the large supply systems, which had adequate capacity and facilities for the proving of circuit breakers, after the example set by the Grand Coulee Power Plant and Electricité de France, with its elaborately equipped testing station at Fontenay.



150KV SUSPENDED CIRCUIT BREAKER

Progress in design formed the theme of the final paper (No. 137) in which L. Alran (Electricité de France) showed the possibilities of a new approach to the design of high-voltage circuit breakers with the aim of simplifying the apparatus and reducing installation and operating costs. Some interesting examples

*Amplitude-factor is defined in this paper as the ratio between the peak restriking-voltage and the peak value of the corresponding recovery-voltage. When used in the assessment of the restriking-voltage severity of a circuit, it refers to the inherent restriking-voltage wave determined by the circuit parameters only and unaffected by the circuit-breaker characteristics.

of circuit breakers designed and manufactured on these lines were described in appendices by A. Thibaudat (F.A.C.E. de Jeumont), Ch. Bresson and M. Gay (A.C.E. de Delle), and A. Viboud (Merlin et Gérin). These appendices illustrated examples of circuit breakers designed to be suspended from a superstructure. Our final illustration shows a 150kV Merlin et Gérin air-blast circuit breaker similar to one installed for test at the Fontenay testing station. This unit has two breaks per pole, each break having a shunt resistor in the form of a distilled water column, which is contained in a horizontal porcelain insulator mounted above the larger porcelain, and in which there is housed the arcing chamber.

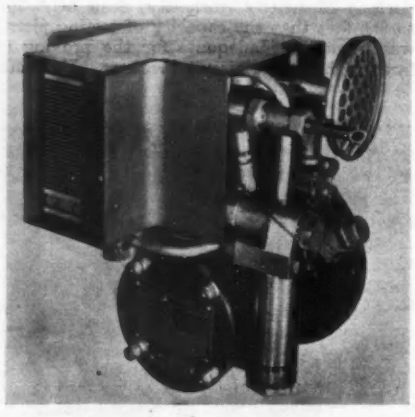
In the discussion on this paper F. J. Lane (British Electricity Authority) put forward the view that plinth mounting of circuit breakers had its advantages and that any change to the underslung arrangement would need to be justified on economic grounds. No costs were quoted in the paper and it would be interesting to know what effects the changes in design would have on circuit breaker costs. Nevertheless, irrespective of the method of support or suspension, the reduction in the weight and bulk of the circuit breaker was an excellent objective provided it was achieved without much complication of the auxiliaries.

(To be continued)

A Lightweight Air Compressor

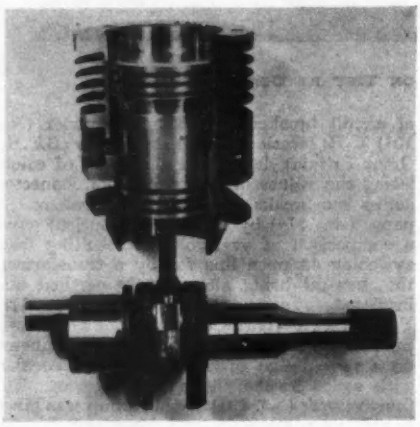
A compact three-stage air compressor for pressures up to 3000 lb per square inch is now being made by the Hymatic Engineering Company, Ltd. This compressor, complete with its intercoolers, &c., weighs only 10 lb, and although primarily intended for use in operating aircraft ancillary services, it has other applications where size and weight are of importance.

WE have received from the Hymatic Engineering Company, Ltd., of Redditch, Worcs, particulars of a small lightweight air compressor which it has developed. This compressor, known as the firm's type "HC.51," is illustrated on this page. It is a three-stage, air-cooled unit with a normal working pressure of 3000 lb per square inch and, through the relief valve setting, a maximum pressure of 3300 lb per square inch. When running at its normal speed of 1500 r.p.m. the unit has an output of 1·4 cubic feet per minute free air delivery, the air temperature being 80 deg. Cent. It is designed to run at 2000 r.p.m. for periods not exceeding fifteen minutes, in order to allow for maximum aircraft engine speeds. Under normal atmospheric conditions an air cooling flow of 85 cubic feet per minute is required, but when the atmosphere temperature rises to 40 deg. Cent., as in the Tropics, the cooling flow necessary is 150 cubic feet per minute. The total weight of the compressor complete, together with intercoolers, relief valves and cowl, is only 10 lb., and its overall dimensions, excluding the driving shaft, are 6in wide, 7in long and 8in high. Lubricating oil is supplied to the compressor at pressures of between 30 lb and 70 lb per square inch from the gear-box of the engine driving the compressor. The truncated piston and stepped cylinder design of the compressor, clearly shown in the photographs, provides effective cooling in the second stage, the cooling surface area being high in relation to the volume. As approximately equal work is done in each stage, torque fluctuation is kept low and the connecting-rod is usefully employed during both strokes.



THREE-STAGE AIR COMPRESSOR

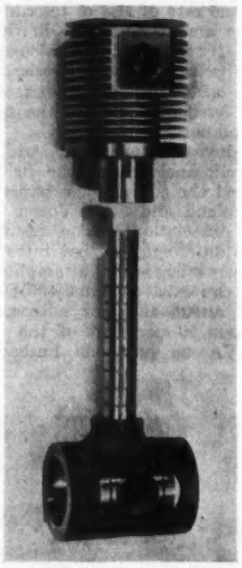
Several problems had to be overcome in the design of the crankshaft and piston assembly, which is shown in one of the illustrations. Lubrication of the upper piston rings is dependent upon the oil which passes the lower set of rings, but at the same time it is necessary to keep to a minimum the amount of oil delivered with the air. Satisfactory control of oil was obtained in design and the maximum carry-over is stated to be only 5 cubic centimetres per hour. To control the oil consumption and to minimise air losses past the piston rings the cylinder, which is made from hardened steel, is finished to extremely fine limits. We are informed that during manufacture cylinder diameters are controlled to 0·0006in and combined ovality and eccentricity are not allowed to exceed the same figure. The necessity for such accuracy is apparent, as the second-stage pressure is about 1000 lb per square inch, and this pressure is trapped between the upper and lower sets of rings.



CRANKSHAFT AND PISTON ASSEMBLY

Air enters the compressor through a filter and then through an annular lightweight plate valve to the first-stage cylinder. After initial compression the air is delivered through a plate valve to a cooler and thence to the second stage inlet valve. Although cooling takes place in the second stage, it is still necessary to cool the air further before it enters the third stage, and for this purpose finned light alloy coolers are provided.

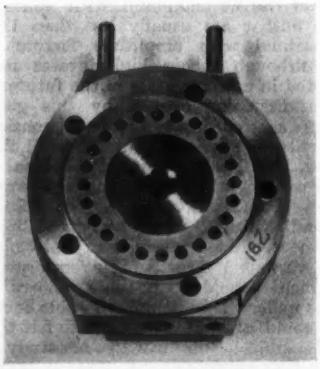
The third-stage components, which we also illustrate, include a scotch crank mechanism to operate the plunger. The motion is sinusoidal and no attempt has been made to balance out the acceleration forces of this system because they are very small and can be safely ignored. The slipper block and crosshead are made from cast iron, a departure from aircraft practice, but a combination which is stated to have proved quite satisfactory. Cast iron is also used for the cylinder, which has aluminium fins bonded to it. The piston, of nitrided steel, ⅜in diameter, has no rings and the gas seal is maintained by using a running clearance of 0·00015in.



THIRD STAGE COMPONENTS

The parts of the first-stage inlet valve and a valve plate and spring of the form common to all other valves in the unit can be seen in one of the photographs we reproduce. The design of the first-stage inlet valve is particularly important because the compressor must be capable of pumping to 3000 lb per square inch at high altitudes—duties for which it is necessary to have a valve with a very low pressure loss. The annular valve plate is located in the recess at the top of the first-stage cylinder bore and no bias spring is used.

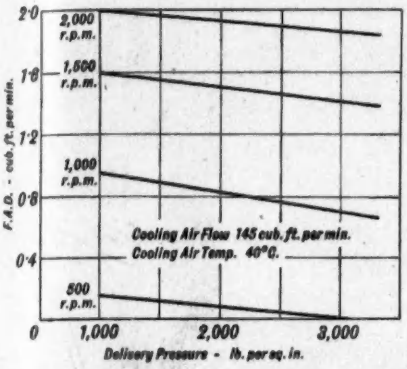
Intercoolers fitted on the compressor, which are made from light alloy bar and have closely pitched fins machined on them, are designed to cool the air to within about 10 deg. of the cooling air temperature. The makers state that during normal running with cooling air at 23 deg. Cent. the air temperature in the high-pressure intercooler is reduced from 143 deg. Cent. to 33 deg. Cent. An aftercooler which is integral with the third-stage cylinder head reduces the air temperature by about 40 deg. Cent.



FIRST STAGE INLET VALVE ASSEMBLY

As the unit is primarily intended for use on aircraft which might be parked in temperatures below freezing point, it was necessary to ensure in design that no water could collect in valve ports, pipes or cylinders. During normal operation water vapour condenses at the base

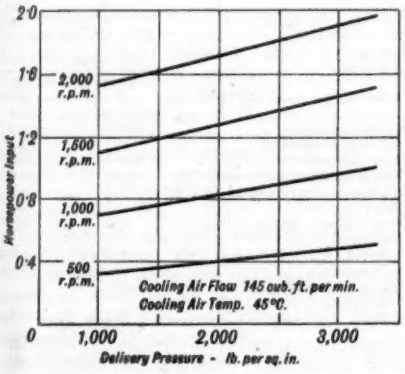
of the high-pressure intercooler, and if no trap were fitted it would be carried over in small drops as long as the unit was running. When the compressor stopped water would also begin to collect in the pipe between the high-pressure intercooler and the third-stage inlet. Condensation also takes place on the walls of the aftercooler, and if precautions were not taken water would drain down into the final delivery



OUTPUT CHARACTERISTICS

valve mechanism. To protect the compressor from damage two water traps are fitted, one between the second and third stages, which empties itself via a non-return valve when the unit is off-loaded, and another at the base of the aftercooler consists of a gallery of sufficient size to collect the few drops of water which run down the aftercooler walls.

Two relief valves are fitted to the unit, one in the second stage delivery valve block and the other on top of the aftercooler. This second



POWER INPUT CHARACTERISTICS

high-pressure valve, which is very small and light, is loaded by two spring washers and is set to blow off at 3300 lb per square inch, the closing member being a conical plug which mates with a square edge seating.

The performance of the unit is shown in the two graphs we reproduce. One graph gives the output at four speeds ranging from 500 r.p.m. to 2000 r.p.m. over the pressure range of 1000 lb to 3000 lb per square inch, and the second shows the power absorbed increases linearly with delivery pressure over the range covered. The peak power is 2 h.p. at 2000 r.p.m. and 3300 lb per square inch, whilst under normal working conditions the power absorbed is 1·5 h.p. at 1500 r.p.m. and 3000 lb per square inch.

A Fireproof Material

THE 1948 Convention of Safety of Life at Sea considered, among other items, the means whereby fire at sea could be prevented or its spread restricted, and to that end certain regulations were proposed which have since been ratified by a majority of the nations with mercantile fleets. As part of the precautions, tests governing the suitability of materials which could be used in the construction of the ship were evolved and included a temperature-time chart linking time with the rate of heat transfer from one side of a bulkhead to the other under certain conditions.

Last year it was announced that a company, "Marinite, Ltd.," was to be formed to produce new fireproof material, known as "Marinite," which fully satisfies the conditions laid down for ship materials and when used for internal constructional purposes, such as joiner work, the installation of a sprinkler system is not required. Although named a new material it is only new with respect to production in this country, it being in current production in America and is used extensively in American ships.

The material was developed some sixteen years ago by the Johns-Manville International Corporation of America, to meet the stringent regulations which resulted from the disastrous fire in the liner "Morro Castle" in 1934. Up to now the material has been imported from America, but after negotiation the British Government has approved the formation of the company, "Marinite, Ltd.," for the production and marketing of "Marinite" in Great Britain. Jointly owned by the Cape Asbestos Company, Ltd., and the Johns-Manville Corporation of New York, the new company has acquired a factory at Germiston, Glasgow, and equipment is being installed to enable production to start in the near future.

"Marinite" is produced from an asbestos base and lime, which are mixed to a slurry and steam-cured under pressure. It is highly resistant to moisture, it does not support vermin, it has a high insulating value and, above all, is incombustible. The low thermal conductivity, which is of the order of 0·80 B.Th.U. per square foot per 1in thickness per deg. Fah. rise in temperature, has been demonstrated by tests in which one side of a panel ½in thick was exposed to a temperature of 1700 deg. Fah. and the amount of heat conducted through to the other face was not sufficient to ignite paper held in direct contact. The material is supplied as pressed board in standard size panels measuring 36in, 42in and 48in by 96in and 48in by 120in, in thicknesses from ½in to 1in. It has ample mechanical strength, weighs approximately 35 lb per cubic foot, and offers a high resistance to the passage of sound. The boards are suitable for passage and divisional bulkheads, ship side lining, panelling of the deckhead and for decorative purposes, and are furnished with a variety of finishes, including a "standard base finish" consisting of a baked on linseed oil treatment glazed ready for the priming coat and subsequent painting, and other waxed wood or plastic veneers. They are also obtainable faced with sheet aluminium or steel and a marine veneer, which is a cement and asbestos composition, giving a hard grey marbleised surface.

The working of the material does not call for any special tools, it can be cut by ordinary joiners' saws, but disc saws with a carborundum rim give better results. Again, ordinary machines in the joiners' shop are suitable for bevelling and rabbeting operations, but for drilling steel-working drills are recommended. It is of interest to note that tests have shown that the material has good screw-holding powers.

THE ROYAL MINT.—During the calendar year 1951 the Royal Mint produced 386,147,406 coins, of which 130,248,510 were United Kingdom coins, 211,527,655 coins for other countries of the Commonwealth, and 44,371,241 coins for foreign governments. Thus two-thirds of the Mint's production during the year were for seventeen Commonwealth and foreign countries, viz., Australia, British East Africa, British West Africa, British Honduras, Burma, Fiji, Hong Kong, Iceland, Iraq, Irish Republic, Jordan, Libya, Malaya, Mauritius, New Zealand, Seychelles and Southern Rhodesia. The coins produced included 2,003,540 five shilling pieces, which were struck to commemorate the Festival of Britain.

Anthracite for Filtration*

By E. L. STREATFIELD, B.Sc., F.R.I.C., M.I.Chem.E.†

IT is unusual to consider anthracite other than as a fuel, but anthracite has assumed an important role in water filtration in recent years as a filter medium in place of the conventional sand. As far as the author is aware anthracite was little used in this country as a filter medium until 1944,[1] but in America from 1935 onwards extensive use has been made of this material.

Research on the use of anthracite as a filter medium was first initiated in America in 1930

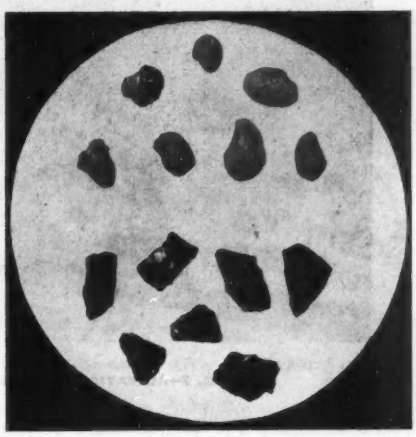


FIG. 1—SAND AND ANTHRACITE GRAINS]

by the Anthracite Institute under the direction of H. G. Turner,[2,3] although as far back as 1896, James H. Fuertes apparently used dredged river coal (as there was no local sand available) in an experimental filter at Harrisburg, Pa., and later several plants were constructed. Little was known about filter media in general at that time, and dredged river coal is not of the right size or shape as shown by Turner's later work. Some of the plants Fuertes constructed

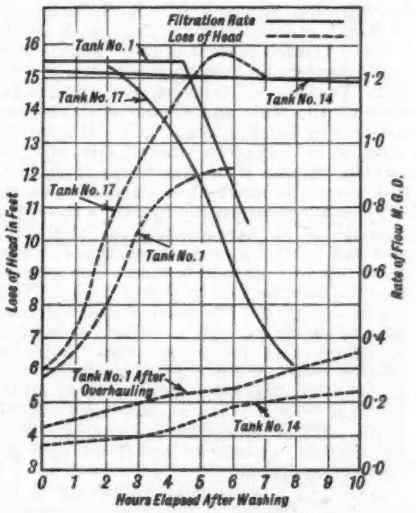


FIG. 2—FILTER PERFORMANCES

are, however, still in operation, but now using specially selected and graded filter anthracite. Turner showed that Pennsylvania anthracite, because of its conchoidal fracture, produced a particle having the most desirable shape for filtration purposes.

Anthracite for filters must be selected material to provide a particle free from small fracture cracks and possessing the best form. This particle must be strong enough to withstand years of backflushing without breaking

* This article is based upon an unpublished paper presented by the author before the Institute of Fuel, South Wales Section, on November 3, 1950.

† Filtrators, Ltd.

into smaller grains, and should be sharp, angular and flat. For these requirements the highest quality of anthracite is essential for satisfactory particle shape and freedom from occluded foreign matter.

In America, filter anthracite prepared from Pennsylvania anthracite is marketed under the trade name of "Anthrafilt." For its preparation the highest quality coal is selected and is sent to the breaker, where it is crushed, thoroughly washed and cleaned by gravity separation methods which free it from slate and associated mineral substances to a low ash product. The crushed material is finally screened over vibrating screens equipped with jets of water which assist in producing the desired size and remove as far as possible all very fine particles. No one standard size is made in the screening process, but instead different sizes are made to meet the various conditions of water treatment, water characteristics, filter design and filter operation.

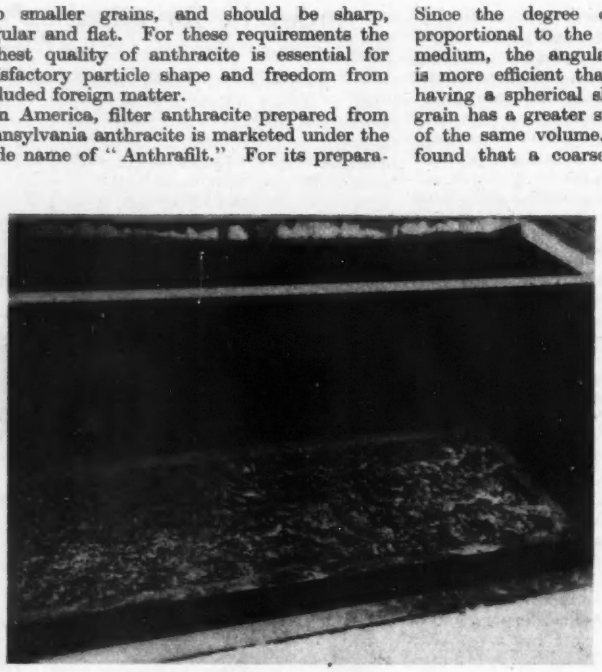


FIG. 3—AGITATION OF FILTER BED

FIG. 4—SEDIMENTATION TANKS AND FILTERS

In this country the best grade of anthracite for filtration purposes is a hard anthracite produced at the Onllwyn Colliery in South Wales. The ash content of these coals is from 4 to 5 per cent and the volatile matter 6·9 per cent. The large coal is passed through a breaker after all the shale and inferior coal has been removed by hand picking. The coal is broken down to a maximum size of 4½in and the material smaller than ⅛in which is made in this process is screened out and sent to the "Filtercoal" preparation plant. Here the —⅛in material is further screened on electrically operated vibrating screens of the following sizes :—2mm, 1mm and 0·6mm. The screened products are bagged in four-ply paper bags containing 100 lb. The outer plys are bitumen lined to enable the bags to be handled in moist conditions, and for export these bags are inserted into an outer jute or hessian bag. It should be emphasised that by breaking the raw coal only to 4½in size, very large wastage in the form of useless fines is avoided. Also, the screening process is carried out with dry material throughout.

Sand, the filter medium commonly in use since the inception of filtration, is composed almost entirely of silica. It is insoluble in most acids, but is soluble in alkalis. Its weight is approximately 100 lb per cubic foot and its particle shape is usually rounded.

On the other hand, anthracite is essentially carbon together with a small percentage of ash-forming mineral matter, and is insoluble in most acids and alkalis. Its weight is approximately 50 lb per cubic foot, and its particle shape is sharp, angular and flat. The contrasting shapes of sand and anthracite grains may be seen from the photograph (Fig. 1), which is to a magnification of 10.

In filtration, especially of water containing very fine material in suspension, a coagulant is employed to agglomerate the solid particles together, so as to be entrapped by the filter. Since the degree of retention is directly proportional to the surface area of the filter medium, the angular particle of anthracite is more efficient than the same size of sand having a spherical shape, because an angular grain has a greater surface area than a sphere of the same volume. It has, therefore, been found that a coarse anthracite particle will effect the same removal of turbidity as a relatively fine sand, with the result that longer runs are obtained between backwashing, lower loss of head is experienced, higher rates of flow can be used, and the bed will be cleaned more thoroughly when backwashed.

Being essentially carbon, anthracite does not react chemically with the constituents of the water, nor with the gelatinous matter which envelopes the grain during filtration. The anthracite grain, therefore, not only releases dirt easily, but it does not become badly coated with lime, manganese or iron. It is of special advantage in filters following the hot lime-soda softening process, as, unlike sand, it will not contribute silica to the boiler feed water, nor will it coat with lime.

Anthracite may be used in filters for a wide variety of purposes, e.g., filters for the removal of oil, swimming bath filters, sewage filters, iron removal filters, portable filters where light weight is important, and municipal filters of gravity, pressure or slow sand type. It can also be used in the filtration of many chemicals which would react with other filter media.

Many cases have been cited in America in recent years of increases in the capacity of filtration plants by the use of anthracite. Fig. 2 shows how the capacity of the filters at the municipal water-treatment plant at Little Falls, New Jersey,[4] was increased by 50 per cent. There was little change in the rate of filtration over a run of ten hours in an anthracite filter (tank No. 14), whereas with a sand filter the filtration rate dropped off rapidly within two to four hours. Air scour was used with these filters. The loss of head in the anthracite filters did not exceed 6ft, whereas in the sand filters it was as high as 12ft to 15ft. Cleaned sand showed a higher head loss than anthracite.

The author first tried out the use of anthracite as a filter medium on a large scale in this country at the St. Anne's Board Mills in Bristol, and the results obtained were so striking that they merit detailed description. The water-treatment plant at this mill has a throughput of approximately 600,000 gallons per hour and consists of twin clarifier tanks followed by sedimentation tanks delivering to a battery of sixteen rapid gravity filters, the whole plant being arranged in two sections of equal capacity. The period of retention in the sedimentation system is one and a half hours and the rate of filtration, with fourteen of the sixteen filters normally in operation, 128 gallons per square foot per hour. The water supply is drawn from the River Avon which has wide variations in quality, as shown in Table I, from typical chemical analyses, the worst conditions being experienced at flood tide when serious pollution occurs from sewage brought up to the mills from the lower reaches of the river :

Owing to progressive deterioration with time of the quality of the river water, by pollution, it was found that the normal and economical dose of coagulants (sulphate of alumina) was inadequate to give efficient flocculation and sedimentation of the solids in suspension, with the result that the sand filters became overloaded and the sand rapidly became fouled. Further, the organic matter settled on the surface of the sand as a blanket, with consequent reduction in filter output. After approximately twelve months' life, the length of filter run averaged from fifteen minutes at some high tides up to one hour,

TABLE I.—*Typical Analyses of River Avon Water at Bristol*

	High tide	Normal river
Reaction, pH value	7·3	7·4
Colour, Hazen	43	30
Turbidity, silica standard, p.p.m.	2300	20
	Parts per 100,000	
Total solids dried at 110 deg. Cent.	537·6	44·1
Solids in solution	406·5	43·6
Solids in suspension	131·1	0·5
Total hardness as $CaCO_3$	108·0	27·2
Temporary hardness as $CaCO_3$	29·2	23·6
Permanent hardness as $CaCO_3$	78·8	3·6
Chlorides as Cl	151·0	3·6
Free carbon dioxide	1·3	0·7
Iron as Fe :		
Total	5·2	0·036
In solution	0·064	0·012
Oxygen absorbed from acid $KMnO_4$, 3 hours at 37 deg. Cent.	2·214	0·660

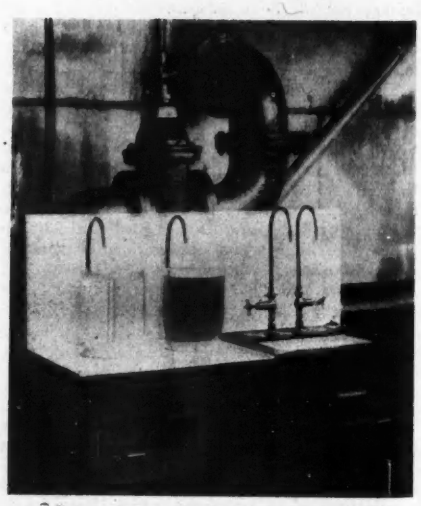


FIG. 5—FILTERED AND RAW WATER

the sand being so fouled that it had to be renewed. Examination of samples of the fouled sand taken through a vertical section of a filter bed showed each sand grain to be heavily coated with gelatinous matter increasing the apparent size of each sand particle to a considerable extent. The gelatinous matter contained besides water and organic matter a considerable amount of aluminium hydroxide and an air-dried sample of the sand showed a loss in weight on ignition of 27·5 per cent.

Each filter bed consisted of a depth of 2ft of filter sand having an effective size of 0·75mm supported on the usual gravel bed. This size of sand had replaced the original, having an effective size of 0·5mm. In May, 1944, the sand in one of the filters (No. 9) was replaced by anthracite having an effective size of 0·5mm. The immediate effect was that the length of filter run increased to four to five hours without any deterioration in the quality of the filtered water, and on the contrary the quality of the filtered water from the anthracite filter was generally better than that from a sand filter. In Table II are given typical results with the anthracite filter as compared with a sand filter for varying quality of raw water delivered to the plant :

The data for all such runs includes the turbidity measured on the silica standard, colour in Hazen units and the organic matter content as measured by the oxygen absorbed from acid potassium permanganate in three hours at 37 deg. Cent.

Observations of the quality of the filtered water from two other filters after changing over from sand to anthracite as compared with that of the original anthracite filter No. 9 are given in Table III :

The encouraging results obtained with one anthracite filter led to the decision to change the sand in the remaining filters for anthracite, and this was completed in April, 1945. Due to difficulties in obtaining exactly the same grading as for the first anthracite filter, the effective size of the anthracite in the remaining filters is 0·6mm. A summary of the operating experience obtained with the anthracite filters, as compared with the original sand filters, is given in Table IV.

It is realised that much improvement could be made in the sedimentation system of this plant, which has become overloaded by worsening raw water conditions beyond anything for which it was designed. It is, however, worthy of attention that the anthracite filter medium should have produced the results which have been described, even under these very adverse conditions.

Having described the improved results which can be obtained in an existing water filtration plant when changing over from sand to anthracite, it is now proposed to refer to a number of new water filtration plants installed for various applications which were designed for use with anthracite filter medium.

The water-treatment plant recently installed at the new Bridgend Paper Mills at Tondu has an output of 60,000 gallons per hour, and consists of twin flocculator tanks and straight pass rectangular sedimentation tanks, and five rapid gravity anthracite filters. The raw water is pumped from the R. Llynfi and is dosed with sulphate of alumina as coagulant in a mixing race, before admission to the flocculator tanks where slowly rotating motor-driven paddles assist the coagulated suspended matter to build up into large and readily settling flocs. The water flows through the settling tanks in which there is a retention period of two hours, and then on to the rapid gravity filters. Each filter has an area of 120 square feet, and contains a filter bed 3ft 6in deep consisting of a 2ft 10in layer of anthracite graded 1mm to 2mm, supported on an 8in layer of coarse anthracite and gravel. The rate of filtration is 100 gallons per square foot per hour. The underdrain system consists of asbestos cement lateral pipes, drilled on the under and upper sides, leading into a central concrete channel. The lateral pipes are designed to ensure uniform draw-off of filtered water and uniform distribution of air and water during backwashing. The upper holes only in the laterals admit the correct amount of air to the filter bed during the air scour which precedes the actual backflush, while both sets of holes come into operation during filtration and also during backflushing. The degree of agitation given to the filter bed by the air scour tending to release dirt from the anthracite grains is illustrated in the photograph (Fig. 3) of one of the filters taken out of service for backwashing. A view of the arrangement of sedimentation tanks and filters is given in Fig. 4, while Fig. 6 shows the filter operating gallery. The clarity of the filtered water compared with that of the raw water can be seen from an illustration (Fig. 5) of the test cabinet and clarity bowls, which are fed continuously with samples of the two waters.

Another interesting application of anthracite as a filter medium is in the de-oiling of steam condensate. Condensate returned from steam-driven plant or derived from steam used for process work frequently contains small amounts of lubricating oil in the form of an emulsion.

FIG. 6—FILTER OPERATING GALLERY

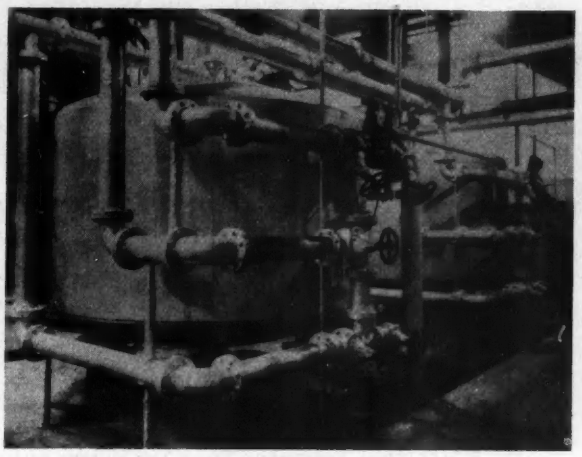


FIG. 7—PRESSURE FILTERS CHARGED WITH ANTHRACITE

TABLE II.—*Filter Results with Anthracite and Sand Filters Running Concurrently (St. Anne's Board Mills)*

Date	Observation	Raw water	Inlet to filters	Outlet filter No. 9, anthracite	Outlet filter No. 10, sand
6/7/44	Turbidity	350	40	Nil	Nil
	Colour	65	46	25	29
	Oxygen absorbed	0·888	0·553	0·314	0·323
7/7/44	Turbidity	280	45	Nil	Nil
	Colour	58	42	28	31
	Oxygen absorbed	1·248	0·536	0·392	0·432
10/8/44	Turbidity	105	30	Nil	Nil
	Colour	60	45	20	27
	Oxygen absorbed	0·550	0·365	0·245	0·278
4/10/44	Turbidity	2000	70	Nil	Nil
	Colour	64	45	36	31
	Oxygen absorbed	3·360	0·611	0·435	0·429

TABLE III.—*Comparison of Filters Nos. 8 and 1 with Filter No. 9 After Change-Over from Sand to Anthracite (St. Anne's Board Mills)*

Date	Observation	Raw water	Filter No. 9		Filter No. 8	
			Inlet	Outlet	Inlet	Outlet
3/8/45	Turbidity	5	3	Nil	3	Nil
	Colour	45	36	27	34	25
	Oxygen absorbed ...	0·45	0·40	0·08	0·41	0·06
					Filter No. 1	
24/10/45	Turbidity	2500	30	Nil	60	Nil
	Colour	82	68	23	57	23
	Oxygen absorbed ...	3·96	0·36	0·28	0·27	0·07

TABLE IV.—*Summary of Operating Experience with Anthracite and Sand Filters (St. Anne's Board Mills)*

	Anthracite filter	Sand filter
Area of filter, square feet ...	336	336
Rate of filtration, gallons per square foot per hour	120–128	128
Effective particle size, mm ...	0·6	0·75
Depth of bed ft	2	2
Minimum length of run, hours	6	15 min
Maximum length of run, hours	10	2
Average length of run, hours...	8	1
Air scour, c.f.m. per square foot filter area	2·7	2·7
Duration of air scour, min ...	5	5
Backwash rate, g.p.m ...	3000	3000
Duration of backwash, min ...	4	6–7

Conditions of bed after twelve months' working :
Anthracite filter : Clean, very little dirt penetration
Sand filter : Unworkable, extreme fouling—sand had to be completely changed

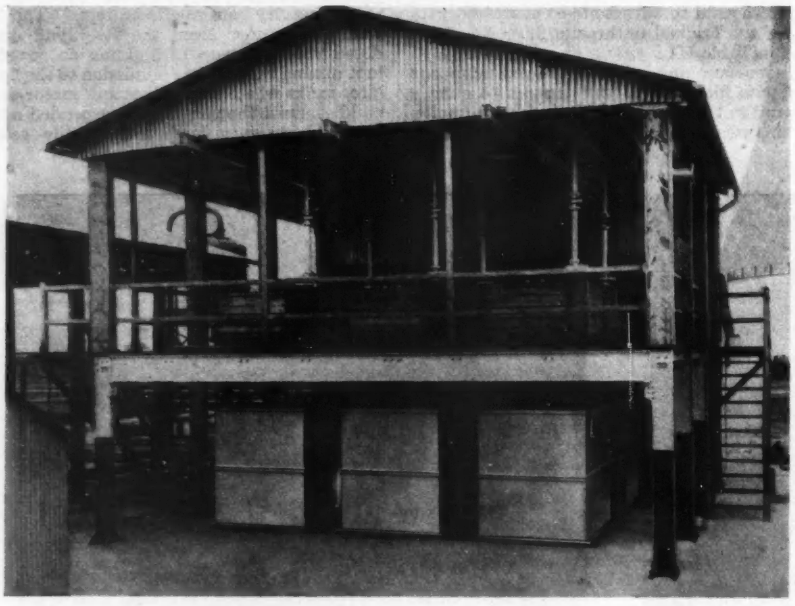


FIG. 8—ELECTRICAL TREATMENT TANKS AND FILTERS OF DE-OILING PLANT

Whilst the larger particles of oil can be removed by mechanical oil separators or filters, the smaller emulsified particles have to be coagulated before removal is possible. The "Filtrator" electrical de-oiling process consists in first coagulating the emulsified oil by passing the condensate between plate type ferrous metal electrodes across which flows a low-amperage direct current causing an induced charge between the electrodes. Positively charged Fe ions from the anode faces of the electrodes travel towards the cathode faces, and in passage the Fe ions neutralise the negative charge of the oil particles forming a coagulum of ferric hydroxide and oil. The treated condensate is then passed on to a rapid gravity filter containing a bed of filter anthracite, the Fe/oil coagulum being readily filterable and anthracite filter media readily cleansed by normal air scour and backwashing. Complete removal of the oil is thus effected and the resultant pure condensate is perfectly safe and eminently suitable for boiler feed purposes. Fig. 8 shows the arrangement of electrical treatment tank and filters of a de-oiling installation having a condensate throughput of 150,000 lb per hour (the installation has recently been extended to 450,000 lb per hour) for a Shell chemical plant. The de-oiling plant is fully automatic, the anthracite filters being automatically air scoured and backwashed at a predetermined loss of head.

So far in this article only gravity filters have been described, and this account of the application of anthracite in filtration would not be complete without reference to its use in pressure filters. At the new Kingston upon Thames power station, water abstracted from the River Thames is used after treatment for feed to evaporators feeding high-pressure boilers. The raw river water is dosed with sulphate of alumina to coagulate fine material in suspension and is then passed through three 9ft diameter vertical pressure filters charged with anthracite, shown in Fig. 7. The rate of filtration is as low as 63 gallons per square foot per hour as presedimentation is not employed. Long filter rungs are obtained between backwashings. The filters are provided with an underdrain system consisting of a nozzle plate fitted with unchokable nozzles, and the filter beds are cleansed by the normal air scour and backwash. The filtered water is softened and freed from ammonia before being fed to the evaporators, the removal of ammonia being accomplished partly by filtration through a catalyst (" Birm ") and partly by ion exchange in carbonaceous zeolite softeners.

Fig. 9 illustrates a standard vertical pressure filter showing a section of the anthracite filter bed supported on the underdrain system just described.

In the filtration plants which have been described, increased capacity from filters using anthracite in place of sand has been obtained as a result of longer filter runs, and conventional filtration rates of around 100 gallons per square foot per hour have been maintained. It has been reported, however, in the American literature[5] that filter capacity has been greatly

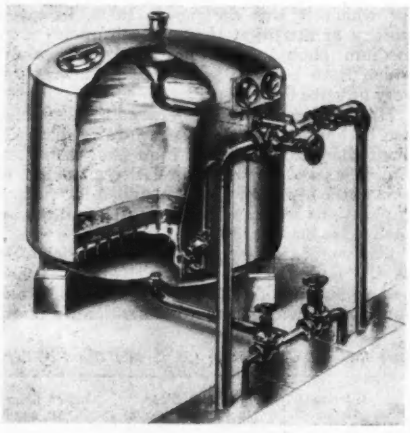


FIG. 9—VERTICAL PRESSURE FILTER

increased by doubling the rate of filtration when changing over from sand to anthracite, and without any noticeable alteration in the quality of the filtered water. Thus, the installation of additional filters may become unnecessary when the capacity of an existing plant has to be increased, resulting in considerable economy and saving of space. Work on a large scale in this direction is likely to be carried out in this country in the very near future.

It is relevant to emphasise at this point that to obtain the best possible quality of filtrate and longest filter runs with anthracite, efficient flocculation and sedimentation systems prior to filtration are frequently necessary, and efficiently designed systems to ensure effective cleansing of the filter bed are absolutely essential.

Circumstances are being discovered where anthracite is of special advantage. Thus, anthracite shows improved results over sand in the filtration of sewage effluents to yield a final liquid of higher quality than that normally accepted for the effluent from a municipal sewage disposal works. Again, anthracite is a better filter medium than sand for waters in which a heavy tenacious floc is formed by the use of activated silica with sulphate of alumina as the coagulant, a recent development in coagulation practice.

The properties of anthracite as a filter medium compared with sand may be summarised as follows. Being essentially carbon, anthracite is more nearly chemically inert than sand, and its conchoidal fracture produces a particle having the most desirable shape for use in filters. Its low specific gravity and angular shape makes possible longer filter runs and more effective filter washing at lower backwash rates. Existing filters may have their capacity increased from 25 to 100 per cent by the use of anthracite, at the same time effecting considerable economy in the consumption of washwater.

What is likely to be the demand for filter anthracite? It is impossible to assess the number of new filtration plants for public supply and industrial requirements which may be installed in the future, but it is possible to obtain some idea of the potential demand for filter anthracite based on existing filter capacity and assuming that the filter sand now used is replaced by anthracite. Thus, the total quantity of anthracite to replace sand in the filter plants of public water undertakings in the United Kingdom would be approximately 40,000 tons. In industry a large user of water is the paper industry, and in existing filtration plants approximately 10,000 tons of anthracite would be required to change over from sand. Other large users of water usually requiring treatment by filtration are power stations, chemical works, steel works, gas undertakings, and so on. To illustrate the growth in use of anthracite which is possible American experience may again be cited. Thus, whereas in 1935 there were only three filtration plants in America employing anthracite, by 1941 there was a total of 1100 filtration plants of all kinds using filter anthracite.

As regards production in this country, the coal preparation plant at Onllwyn is at present producing only relatively small quantities of filter anthracite, but a large plant is, however, projected for an output of 70 tons per day of filter anthracite of all grades, which should satisfy all requirements for a considerable time.

Finally, the cost to the user. Filter anthracite costs more per ton than filter sand, but since it takes half as many tons to fill a given space, it is, in fact, no more expensive than sand volume for volume.

In conclusion, the author desires to thank Filtrators, Ltd., for its permission to publish this article and to use the photographs of their plants which have been described. The assistance of many in assembling the results of operating experience with anthracite is also gratefully acknowledged.

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[2] H. G. Turner, *Ind. Eng. Chem.*, 1943, 35, 145.
[3] H. G. Turner, *Journal A.W.W.A.*, 1944, 36, 431.
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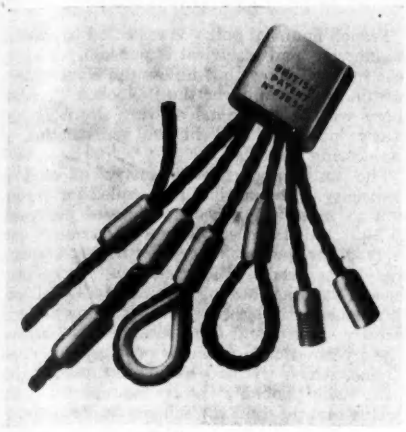
[5] A. H. R. Thomas, *Water and Sewage*, April, 1945, 68 and 70.

A Wire Rope Clamping System

A SYSTEM of joining wire ropes by the use of special clamps, which has been introduced into this country by Cable Covers, Ltd., St. Stephen's House, London, S.W.1, is designed to replace normal highly skilled and expensive splicing methods. This system, known as the " Talurit " system, was demonstrated in London last week. With it the joining of wire ropes becomes a simple, quick, semi-skilled operation. Not only does the system eliminate the use of skill, but it also promotes a considerable saving in wire rope as it reduces the length required to make a joint by some 85 per cent as compared with splicing.

The system makes use of specially designed clamping ferrules which, as can be seen in one of the illustrations reproduced on page 775, are made in a number of forms for different

applications. These ferrules are made from a copper-free aluminium alloy which flows freely when cold worked. To apply a ferrule it is simply slipped in position over a wire rope or ropes and then closed in on a press using specially shaped and dimensioned dies or swage blocks. Under the pressure exerted by the dies the ferrule metal flows into the interstices of the rope to give an intimate contact over a large irregular area. The dimensions of the dies are such that when they are fully closed the correct weight/pressure ratio has been exerted to mould the two ropes and ferrule into a rigid mass. In this cold working



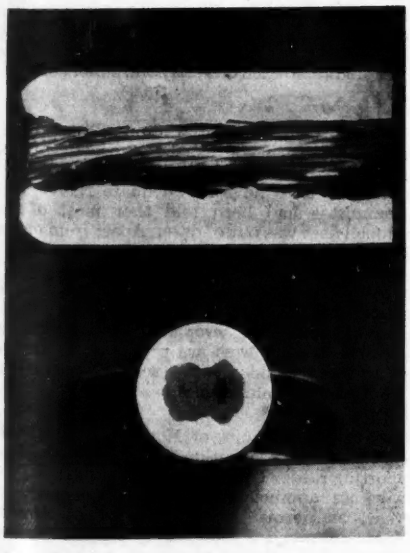
CLAMPING FERRULES

operation the shape of the ferrule is so changed, and the wires of the ropes compressed together, that two thicknesses of rope are confined in a space little more than that normally occupied by a single thickness. The degree of compression which occurs in a ferrule and the way in which the metal flows in its bore when it is compressed on a wire rope can clearly be seen in our second illustration.

The system has been developed and ferrules are available for splicing wire ropes up to 4½in circumference in the standard range, and up to 6½in when specially required. A full range of dies and ferrules for all sizes of ropes is made by the firm, which also supplies the necessary presses. These presses are made in four capacities—a hand-operated hydraulic unit of 22 tons capacity for ropes up to ⅝in circumference; a hand or power-operated unit of 50 tons capacity for rope from ⅝in to 1¼in circumference; a 300 tons capacity power-operated unit for ropes from 1¼in to 2½in circumference, and a 1000 tons unit for ropes from 2½in to 4½in circumference.

This method of securing wire ropes has been approved by the committee of Lloyd's Register of Shipping and a number of other authorities.

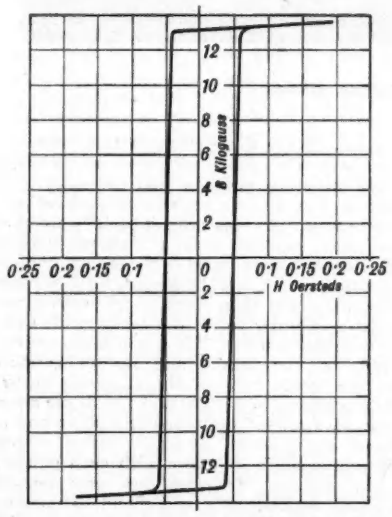
We are informed by Cable Covers, Ltd., that no restrictions will be placed on the use of the "Talurit" wire rope clamping system, and that the complete series of presses will be available to makers and users of wire ropes under licence. To the users of the presses there will also be made available the clamps and swages as well as the maker's technical assistance. Users of wire ropes whose applications are not wide enough or large enough to warrant the installation of clamping plant will be able to obtain "Talurit"-ed wire ropes to their own specification from the wire rope manufacturers or finishers.



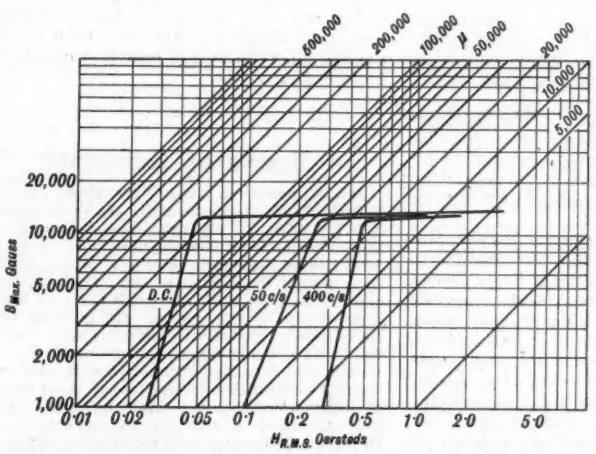
SECTIONS THROUGH FERRULE AFTER APPLICATION

A High Permeability Nickel Iron Alloy

THE method known as domain orientation has been used to produce a new nickel iron alloy, "Permalloy F," which has a markedly rectangular hysteresis loop and a low value of coercive force. It is, therefore, very suitable as a core material for all forms of saturable reactor. "Permalloy F" is produced by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2, in the form of toroidal cores wound from thin tape, and these cores are supplied in the fully heat-treated condition ready for winding. Like all magnetic materials which have high permeability, "Permalloy F" is somewhat strain-sensitive and needs to be handled with care during winding and other processing if its outstanding magnetic properties are to be fully retained. For some designs it may be advisable to place the core in a box before winding; this will serve both to avoid straining the core during winding and to prevent the penetration of coil-impregnating compounds into the core.



D.C. HYSTERESIS LOOP OF PERMALLOY "F" (THICKNESS 0.002IN)



D.C. AND A.C. MAGNETISATION OF PERMALLOY "F" (THICKNESS 0.002IN)

The magnetisation characteristics are shown in the lower diagram, from which it will be seen that a flux density of nearly 14,000 gauss may be obtained in magnetising fields of less than 0·1 oersted. A d.c. hysteresis loop is shown in the first diagram; from a maximum flux density of 13,500 gauss, the remanence is greater than 13,000 gauss, while the coercive force is less than 0·05 oersted, thus resulting in a hysteresis loss of only 210 ergs.

The specific gravity of the alloy is 8·4 and the electrical resistivity is 26 microhms per centimetre cube.

The core sizes which are proposed are as follows:—

Outer diameter, inches	Inner diameter, inches	Height, inch	Thickness of tape, inch
2·25	1·50	0·5	0·004 or 0·002
1·75	1·00	0·5	0·004 or 0·002
1·50	1·00	0·25	0·004 or 0·002
1·50	0·75	0·5	0·002
1·00	0·50	0·25	0·002

For very small cores for memory circuits and computers, sizes will be standardised as the need arises.

American Engineering News

(By our American Correspondent)

The Kings River Power Plan of the Bureau of Reclamation

The Secretary of the Interior has forwarded to State and Federal officials for review and comment a report on a proposed plan for the Federal hydro-electric power development on the North Fork of the Kings River in California as a part of the Central Valley project. This plan of development, which is designed to meet expanding agricultural and industrial needs in the Fresno area of California and other parts of the valley, includes and supersedes a former plan for constructing the initial features of the North Fork development. The programme contemplates the generation of power by six plants on the river, including a 45MW installation at the Pine Flat dam, which is now under construction by the U.S. Army Corps of Engineers, and the acquisition and enlargement to 115MW capacity of the 31·5MW Balch power station, now operated by the Pacific Gas and Electric Company. The six plants would have a total installed capacity of about 350MW and, with firm power assistance from the proposed Central Valley project steam-electric station, would produce an estimated annual output of almost 2,000,000,000kWh of electric energy. The new power development would be integrated both operationally and financially with the Central Valley project in California. This integration will provide a firm power supply for pumping project water from the Friant-Kern canal to the irrigation districts along the canal, which are contracting for Central Valley project water. It will also increase the amount of firm commercial energy available from the Central Valley project as a supply for the future agricultural, industrial and other loads in the Kings River service area and in the San Joaquin Valley. The plan of operation for the new power development, designated officially as the North Fork Kings Unit, Kings

River Division, Central Valley Project, includes the following features: (1) Helms dam and reservoir, about half a mile downstream from San Meadow on the Helms Creek. A concrete dam 320ft high and 1000ft long, providing for the storage of 103,000 acre-feet of water.

(2) A diversion system, including about 6 miles of tunnels, to divert the flow of the Post Corral Creek, the Fleming Creek and the North Fork of the Kings River into the Helms reservoir for storage and release when required.

(3) Wishon dam, reservoir and power station, at the lower end of Collidge Meadow on the North Fork of the Kings River. The dam will be a combination earth-and-rock-fill structure 267ft high and 4350ft long. The reservoir will have a storage capacity of 128,000 acre-feet, and will create a lake almost 3 miles in length with a surface area of 1000 acres. The Wishon power station, with a capacity of 10MW, will be situated at the downstream toe of the dam.

(4) Helms power station will be situated on the shore of Wishon reservoir and will have a capacity of 41MW. A 2½ mile-long tunnel, which will be nearly 8ft in diameter, will carry water from Helms reservoir to the power station penstocks.

(5) Haas power development, on the west side of the North Fork of the Kings River, 2000ft downstream from Wishon dam. Here, a diversion tunnel 6·1 miles in length and 9ft 6in in diameter, will be driven through rock canyon walls to penstocks leading to four generators of 26·5MW capacity each.

(6) Balch power development, which is to include the acquisition from the Pacific Gas and Electric Company of the existing diversion dam, tunnel, penstock, power station and afterbay, together with the installation of additional penstocks and the enlargement of the power station, to have a total capacity of 115MW.

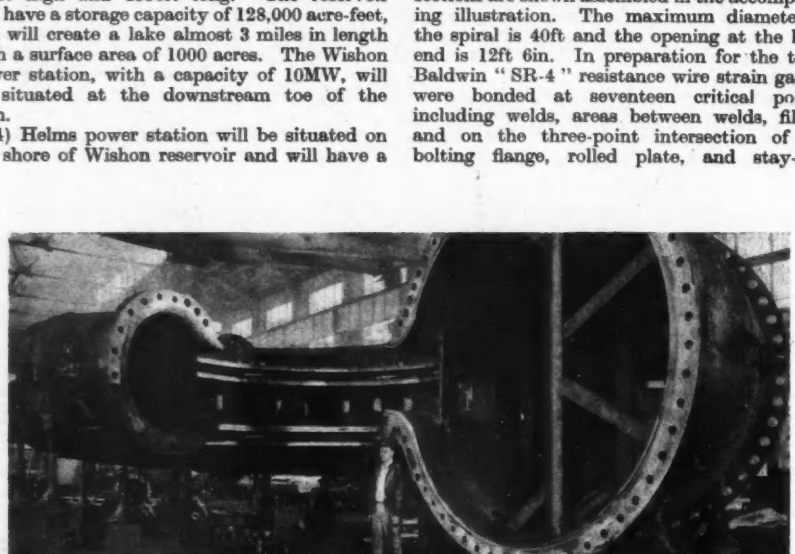
(7) Kirch power development which will utilise the available drop between the afterbay at the Balch plant and the Pine Flat reservoir. A tunnel will be bored on the north side of the North Fork and a power plant situated on the shore of Pine Flat reservoir would consist of two power-generating units, each of 18MW capacity.

(8) Pine Flat power station. The construction by the Corps of Engineers of the Pine Flat reservoir is already in progress and outlets for penstocks are to be provided in the dam. The power plant will have an installed capacity of 45MW.

The power development programme also provides for transmission and substation facilities to distribute the power to the Kings River service area and surrounding territory and to provide the necessary interconnection with the Central Valley project power system. It also includes a 90MW enlargement to the proposed Delta steam-electric power station of the Central Valley project. The capital costs of construction of the entire North Fork Kings Unit, which have been estimated at 196,300,000 dollars, would be repaid to the U.S. Government, with interest at 3 per cent, from the sale of power developed by the enlarged Central Valley project.

A Large Welded Turbine Scroll Casing

Strain gauge tests were made recently on the welded turbine scroll casing for a 70,000 h.p. turbine, which the Baldwin-Lima-Hamilton Corporation of Philadelphia is building for the power station of the Detroit dam, now under construction by the U.S. Army Corps of Engineers. The turbine scroll casing weighs 116 tons and is made up of seven welded sections of heavy steel plate with flanges for bolting the sections together. Six of these sections are shown assembled in the accompanying illustration. The maximum diameter of the spiral is 40ft and the opening at the large end is 12ft 6in. In preparation for the tests, Baldwin "SR-4" resistance wire strain gauges were bonded at seventeen critical points, including welds, areas between welds, fillets, and on the three-point intersection of the bolting flange, rolled plate, and stay-ring casting. Since these strength tests were performed in conjunction with hydrostatic leakage tests, moisture proofing was necessary. The first step in this respect was an application of cerese wax. An area around each strain gauge was then covered with a waterproof paper, which was in turn sealed to the casing by means of waterproof, 2in wide surgical adhesive tape. The whole was then painted over with a resin paint. In order to fill the casing with water, it was sealed by a 12ft 6in diameter drumhead on the intake and by a barrel-ring on the inside bore of the stay-ring casting. Test pressures of 95, 190 and 285 lb per square inch were applied by means of a pump and the shop accumulator system. Seven strain measurements were made with each gauge at each pressure. Zero readings were repeated on each measurement and found to return to within plus or minus 5 micro-inches. The unit is the first welded casing of large size to be built in the shops of the company. Compared with an equivalent casing design in cast steel, weight savings have been found to amount to 20 to 30 per cent and cost savings to 15 to 20 per cent.



WELDED TURBINE SCROLL CASING

Books of Reference

British Standards 1952 *Year Book.* London: British Standards Institution, 24, Victoria Street, S.W.1. Price 7s. 6d. net.—The 1952 edition of this reference work contains a complete list of the 1800 British Standards current at March 31, 1952, with a brief description of the subject matter of each. The Year Book also gives particulars of the membership of the general council and of the Institution's divisional councils and industry standards committees. These industry standards committees, fifty-nine in number, each represent a major British and industry through them the work of drafting British Standards is delegated to some 2200 technical committees and sub-committees. In addition twenty special committees, some of an advisory category, are listed.

French Engineering News

(By our French Correspondent)

The "Orphée," the first of three similar cargo vessels, was recently launched at the yard of the Chantiers Dubigeon. This craft has a length between perpendiculars of 76m, a moulded breadth of 11·95m, and a depth to the main deck of 5·1m. The ship will carry a deadweight of 1617 tons and will have a loaded draught of 4·5m. The "Orphée" will be driven by a M.A.N. eight-cylinder, four-stroke, single-acting supercharged engine, developing 2050 b.h.p. (maximum). The vessel's service speed will be 13 knots, at 1800 b.h.p. There will be two 130kW diesel generators.

* * *

French financial policy is expected to restrict engineering and electrical expansion. Figures just released show that unless the Government can find loans to cover the "blocked" credits there will be a serious slowing down in the heavy industries and in the construction of engineering projects.

The most important industry affected is electricity. The original plan called for expansion to meet a 7 per cent increase per year. In 1951, this increase reached 14 per cent, and in 1952, for the first three months, the increase was 10 per cent. Electricité de France may lose £14 million out of a total of £35 million, thus causing the slowing down of many projects already started and the abandoning of others. The hydro-electric schemes on the Rhine and Rhone, which were to have been started this year, will probably be postponed at least twelve months, and the scheme at Montelimar, on the lower Rhone, which was to be complementary to the almost completed Donzere-Mondragon project, will not be built yet. It is estimated that such economies would throw 8000 workers on the labour market. Further, if the loans do not succeed, 1953 may see an electricity shortage. Similar economies would bring the construction of thermal power stations almost to a standstill, and the postponement of the construction of pithead thermal plant to augment Electricité de France's production.

Railway electrification will, it is thought, stop with the termination of the Paris–Lyons line. Marshalling yards, which were down for extension and rebuilding, may have to serve in their present condition for some years yet, and there may be a reduction in bridge construction and repair. It is thought, however, that failure to develop the marshalling yards would have the most serious effect. Traffic is higher than before the war and there are fewer trucks. Turn-round is of vital importance, therefore, and failure to enlarge the yards would result in a general slowing down in French economy.

Irrigation work, rural electrification and the laying of rural water systems would also be seriously affected.

All these measures will depend upon the success of the loans which are expected to be floated this month. Should they fail to provide the credits, French economy will suffer considerably.

* * *

The French Senatorial Committee on Rearmament recently decided that construction of no less than 30,000 tons yearly must be planned if France is to have an adequate Navy. The Committee had been told that most of the French fleet was out of date. Apart from one or two vessels, the fleet consists of pre-war ships.

* * *

An American mission has reached France, where it will place contracts for the manufacture of moulds for aeroplane fuselage sections. Several French firms are preparing estimates. With these moulds fuselage sections can be cast from ingots of aluminium.

* * *

Monsieur Begonin, of Monaco, has invented and placed in production a plastic cartridge for sporting rifles. This cartridge, it is thought, will save an appreciable quantity of copper per year, as normal cartridges contain between 4 grammes and 5 grammes of copper. French cartridge production amounts to about 200 million per year.

Industrial and Labour Notes

Changes in Wage Rates

The latest figures dealing with changes in wage rates, published by the Ministry of Labour, show that during April there came into operation increases for 945,000 workers aggregating approximately £212,000 a week. Among those who received pay increases during April were workers in the iron and steel industry, on account of sliding scale arrangements based on the cost-of-living index, workers employed by river authorities in England and Wales, and apprentices, youths and boys in the engineering and allied industries. The latter group received increases ranging from 5s. 6d. a week of forty-four hours at fifteen years of age to 11s. a week at twenty and under twenty-one years.

The Ministry of Labour says that, in the first four months of this year, changes in wage rates which took effect resulted in increases aggregating £1,657,100 in the weekly full-time wages of 4,097,500 workpeople. In the corresponding months of last year there were increases aggregating £2,343,000 a week in the wages of 5,910,000 workpeople. In the group of industries classified by the Ministry as "engineering, shipbuilding and electrical goods" approximately 384,500 workpeople received increases aggregating £169,700 a week during the four-month period January to April this year. In that period no decreases in wage rates in any industry were reported. The index of rates of wages (June, 1947=100) stood at 128 for all workers at the end of April. At the end of last year it was 126. In that period the biggest rise in the index—132 to 137—occurred in the case of juveniles.

Railway Wages

The annual conference of the Associated Society of Locomotive Engineers and Firemen was held at Margate last week. At its conclusion it was announced that the delegates had endorsed the policy adopted by the executive committee, which had resulted in a claim being submitted for a 10 per cent increase in wages, with higher payment for Saturday afternoon work. This claim, it will be recalled, has been presented jointly by the three railway unions to the Railway Executive and the London Transport Executive.

The statement by the Associated Society of Locomotive Engineers and Firemen said also that strong feeling was expressed at the conference concerning the delay in bringing into being a pensions scheme for the wages grades. The executive committee was directed "to exert the utmost pressure to ensure that an adequate pension scheme be agreed at an early date." In the event of satisfaction not being obtained in this respect by the end of the year, the statement added, the executive committee was instructed to reassemble the conference for the purpose of reviewing the situation and formulating definite policy.

Taxation and Productive Efficiency

Speaking at the annual general meeting of the London Brick Company, Ltd., on Thursday of last week, the chairman, Mr. A. T. Worboys, said that schemes for greater productive efficiency in any would-be progressive concern were often retarded, and sometimes made impossible of achievement, by the continuing heavy burden of taxation upon industry. Mr. Worboys commented that it was a disturbing fact that during the past twelve months "the brakes upon industrial progress, so far from being slackened, had been pulled several notches tighter."

Mr. Worboys went on to suggest that a comparatively minor but melancholy example was the heavy increase in the tax on diesel motor fuel to a total of 2s. 6d. a gallon upon a source of power which was vital to modern industry. The reports of the productivity teams which had visited the U.S.A., he said, had emphasised the necessity for British industry to develop the use of mechanical handling. The most important recent contribution to materials handling, Mr. Worboys asserted, was the fork-lift truck, which, he added, had formed the backbone of his company's recent increased mechanisation. But, he observed, this swingeng increase in the tax upon diesel fuel, in addition to its widespread effect upon general costs, was, in his view, a direct discouragement of the greater use in British industry of potent aids to increased productivity.

Industrial Production

The official index number of industrial production (1946=100)—which is prepared by the Treasury—has been estimated provisionally at 148 for all industries in March, compared with 149 in February. Last year the figures for the corresponding months were 141 for March (when the Easter holiday occurred) and 151 for February. Taking the manufacturing industries alone, the index for March this year is estimated as being 152, compared with 154 in February; in February, 1951, it was 157. The Treasury says that, from the information so far received, the index for all industries in April this year is expected to be 138 or 139. The effect of the Easter holiday will, of course, be reflected in the figure.

Co-operation in the Coal Mining Industry

In an address, delivered last Friday to the National Association of Colliery Managers, the chairman of the National Coal Board, Sir Hubert Houldsworth, claimed that the great need in the coal mining industry was for better human relations. He said that relations between managers and men varied a good deal, but nearly everywhere they were in a greater or lesser degree bedevilled by past history, ancient feuds, and the memory of grievances and hardships long past. In the last five years, Sir Hubert asserted, much had been done to correct that state of affairs, but he considered that much remained to be done.

Sir Hubert went on to say that every management officer who, by combining justice with tact, overcame a local difficulty, made a contribution to the solution of the coal mining industry's most important problem. The Coal Board's national plan, he added, was based on existing technique and existing proved mechanisation, but he felt it would be a sorry story if by 1960 or 1965 mining techniques and machines had not both been improved so that the productive efficiency of the industry had been materially improved upon. The forecast in the national plan, Sir Hubert said, should be regarded as a minimum.

Trade Disputes

According to figures published in *The Ministry of Labour Gazette*, there were 159 stoppages of work through industrial disputes in the United Kingdom in progress during April. As a result of them it has been estimated that 78,000 working days were lost by 36,100 workers. In March there were 162 stoppages through disputes, involving 42,500 workers and causing a loss of 288,000 working days. In the first four months of this year there were 560 stoppages of work through disputes reported to the Ministry. In them 118,100 workpeople were involved directly and indirectly, and on account of them 521,000 working days were lost. In the comparable period of 1951 there were 567 stoppages reported, resulting in an aggregate loss of 713,000 working days by 128,600 workpeople.

The Ministry of Labour has made an analysis of the stoppages of work through industrial disputes which occurred in 1951. The number of stoppages reported throughout the year was 1719—compared with 1339 in the preceding year—and there were four other stoppages which began towards the end of 1950 and continued into the early part of 1951. The total number of stoppages in progress last year was thus 1723, involving altogether more than 379,000 workers and causing an aggregate loss of 1,694,000 working days. The Ministry's analysis shows, among other things, that 48·5 per cent of last year's stoppages were over wage disputes; 2·2 per cent concerned hours of labour, 14·9 per cent were over the employment of "particular classes or persons," and 31·1 per cent were related to "other working arrangements, rules and discipline." The remaining 3·3 per cent of the stoppages resulted from disputes over "other causes" and from sympathetic action.

The Ministry of Labour says that more than one-third of the aggregate loss of time through stoppages last year occurred in the transport industry, in which approximately 600,000 working days were lost. A large proportion of this loss of working time was in the various stoppages in the docks. One-fifth of the working days lost in 1951 was accounted for by the coal mining industry, although there was only one stoppage of considerable size. It affected South Wales in particular and was in sympathy with workers whom it was proposed to transfer to another colliery through redundancy owing to the closing of part of the workings. There were several stoppages of work last year in the vehicle building industries, and there was one protracted stoppage in the electricity supply industry. It occurred in London and the Home Counties in protest against the suspension of a member of the Electrical Trades Union for refusing to work with an electrician's mate who was a member of another union. This stoppage began in the middle of February and lasted for about two months, with the loss of some 60,000 working days.

Trade Unions and Rearmament

The general council of the Trades Union Congress has issued a statement setting out its views on rearmament. It says that, "because of their conviction that the United Nations and defence pacts for which it provides must have the power of arms to enforce peace, trade unionists have recognised, and overwhelmingly agreed upon, the immediate necessity of rearmament."

The statement deals with the economic factors affecting rearmament, pointing out that consideration must be given both to the plans that have been made for effective defence and to what can be achieved with the materials and capacity available. It was foreseen when the arms plan was framed, the statement adds here, that its implementation must depend on economic circumstances, including American aid. The T.U.C. says that expenditure on armaments is not the sole or the most significant source of the balance of payments problem, and urges that the only practical solution of that problem lies in the ability of this country to expand its export trade. On the face of it, the statement continues, it does not appear that a simple curtailment of our rearmament programme can be an immediate solution of the problems besetting the national economy. Present tendencies towards restriction of their imports in other countries may be of short, or long, duration and may get worse before they are reduced or removed. For the time being, the T.U.C. suggests, those tendencies are the main obstacle to the restoration of our balance of trade and the stabilisation of our economy.

The statement ends by expressing the T.U.C.'s firm conviction that the greatest possible measure of rearmament must be carried out within the limits of this country's power to find the means. Within those limits, the T.U.C. observes, there is a direct obligation upon trade unionists to assist in enabling the country to meet the task it has undertaken.

Steel Supplies

The Minister of Supply, Mr. Duncan Sandys, has stated in a written reply that it is expected that the rate of import of steel will increase somewhat in the third quarter of this year. At the same time, there should be some increase in the weekly rate of steel production at home. But, the reply adds, since the third quarter includes the summer holiday period, the total steel supplies for the quarter will be slightly less than they were in the secondquarter.

Notes and Memoranda

Air and Water

CARRIAGE OF DANGEROUS GOODS IN SHIPS.—The Minister of Transport has accepted, subject to minor reservations, the recommendations made in the report of the Departmental Committee on the Carriage of Dangerous Goods and Explosives in Ships, published in February this year. The Minister's acceptance is announced in a notice (No. M.365), which points out that the substances classified in the report are not to be regarded as a full list of dangerous goods. When it is wished to ship any substance which possesses dangerous properties and which is not provided for in the report the case should be submitted to the Ministry of Transport for consideration.

RESTRICTIONS ON AVIATION SPIRIT.—The Ministry of Fuel and Power says that, as work has been resumed in a number of oil refineries in the U.S.A., it is possible to make some relaxation on the restrictions on the consumption of aviation spirit in the United Kingdom by increasing the amount that can be supplied to operators of civil aircraft during the period May 12th to June 9th by 20 per cent. An Order has been made increasing the supplies allowable during the four-week period from 65 per cent to 78 per cent of supplies made during April. The Ministry adds, however, that it will be some time before normal conditions can be restored and it will be necessary to continue some restrictions after June 8th, the terminal date of the Control of Aviation Spirit Order (S.I., 1952, No. 929).

Miscellanea

EXHIBITION SPACE AT THE B.I.F.—In reply to a question in Parliament last week, The Parliamentary Secretary to the Board of Trade, Mr. H. Strauss, said that the total space available at this year's British Industries Fair was about 1,050,000 square feet. The total space let to exhibitors was 921,500 square feet.

NEW INDUSTRIES IN NORTHERN IRELAND.—The Northern Ireland Ministry of Commerce states that, under the Industries Development Acts, it has undertaken to give grants totalling £1,212,609 towards the establishment of new industrial undertakings. Of that amount, £770,533 has been paid to date. Towards the expansion of existing undertakings in Northern Ireland the Ministry has undertaken to make available the sum of £363,998 by way of grants, and of that amount £255,941 has been paid to date.

ALUMINIUM ALLOY WELDING.—We are informed by Murex Welding Processes, Ltd., that the company's latest 5 per cent silicon electrode produces welds having a minimum tensile strength of 10·5 tons per square inch and has been approved by the Ministry of Supply for the welding of military bridging equipment. The electrode is designed for the downhand position, but can be used in all positions and those of larger gauge can be used with currents up to 400A d.c. for deep penetration of aluminium sections ⅜in thick without special edge preparation or preheating.

NATIONAL FUEL POLICY.—At the recent annual conference of the Institution of Incorporated Plant Engineers, it was decided that a national fuel policy committee should be set up within the Institution. During a discussion of the matter at the conference it was suggested that the views of the users of fuel and power were heard far less than the views of fuel and power suppliers. It was felt, therefore, that the Institution, representing technical users of fuel and power in industrial production and services, was competent to offer views and recommendations on fuel policy to the Government and to any advisory bodies set up by the Government.

LUBRICATION FILM.—An educational and instructional film, which runs for fifty-five minutes, "The Basic Principles of Lubrication," has been made for the Esso Petroleum Company, Ltd., and provides a lucid exposition of the fundamentals of lubrication and so contributes towards a better understanding of the subject. It is available for exhibition to students, technical colleges and research organisations and 16mm copies may be obtained upon application to the Manager, Industrial Sales Department, Esso Petroleum Company, Ltd., 36, Queen Anne's Gate, London, S.W.1. There are four sequences, which deal in turn with friction, fluid-film lubrication, boundary lubrication, and extreme pressure lubrication. Part I of the film defines the laws of friction by experiment and by means of models shows the form of surfaces in contact and the effect of elastic and plastic deformation. Examples of fluid film lubrication are shown and a journal running in a bearing serves to illustrate boundary lubrication. The build-up of the pressure wedge is demonstrated, together with the effect of the introduction of oiliness agents. In the last sequence, dealing with extreme pressure lubrication, additives are used, which form metallic soaps and so reduce the danger of seizing due to local excessive rise in temperature. Throughout the film extensive use is made of laboratory demonstrations, microphotography, animated diagrams, and radio-active technique to explain clearly the principles involved in the lubrication problem.

UNITS AND STANDARDS OF MEASUREMENT EMPLOYED AT THE N.P.L.—No. III, ELECTRICITY.—The third booklet in the series "Units and Standards of Measurement Employed at the National Physical Laboratory," is entitled "Electricity" and is published for the D.S.I.R. by H.M. Stationery Office, price 9d., postage 1½d. It gives an account of the units used for the measurement of electrical quantities and the standards whereby these units are determined, preserved and applied to modern techniques, including r.f. work. The main events in the history of the subject, the relevant international agreements and the legal position, are briefly reviewed in the book.

DEFERMENT OF FESTINIOG HYDRO-ELECTRIC SCHEME.—The British Electricity Authority states that it has decided not to proceed (in the North Wales Hydro-Electric Power Bill, 1951–52, now before Parliament) with the promotion of those provisions which relate to the Festiniog scheme. As the result of discussions with other interested parties, the Authority's advisers have considered further facts recently brought to their notice regarding geological and other conditions affecting the proposed reservoir at Llyn Cwmorthin and the measures to be taken to safeguard the adjoining quarry workings. In consequence, the Authority considers that further action on this scheme should be deferred to allow for a review and possible modification of these works.

A FLUORESCENT INK FOR CRACK DETECTION.—A new fluorescent ink called "Glo-Mor" has been developed by the Manchester Oil Refinery, Ltd., for non-destructive crack detection in light metals, nonferrous alloys, stainless steels and plastics. This ink depends for its action upon deposition in surface cracks of a material and fluoresces when irradiated with ultra-violet light. The ink can be applied to the surface of cleaned, degreased workpieces by either dipping, brushing or by pouring over that portion which requires examination. The makers state that only two minutes are required to prepare and inspect a typical degreased test piece. The indication produced is clearly visible to the naked eye, the cracks showing up in brilliant green colour when the test piece is examined in ultra-violet light.

R.I.C. PREMIUMS FOR TECHNICAL WRITING.—The panel of judges appointed by the Radio Industry Council to award premiums to the authors of articles deserving to be commended by the industry hopes to make its first awards in respect of articles published between January 1 and June 30, 1952. This will enable the results to be announced and cheques presented at the National Radio Show, to be held at Earls Court, London, from August 26th to September 6th. Premiums of 25 guineas each—up to an average of six per year—are offered. Authors of published articles, or editors publishing them, are invited to submit for consideration articles published during the first six months of the year to the Secretary, Radio Industry Council, 59, Russell Square, London, W.C.1, not later than July 7th. Only non-professional writers contributing to journals available to the public are eligible at present. Full particulars of the competition are available on request.

ALUMINIUM IN PUBLIC SERVICE VEHICLES.—We have received from the Aluminium Development Association, 33, Grosvenor Street, London, W.1, a publication entitled *Guide to the Use of Aluminium in Public Service Vehicles* (price 2s. 6d.), which contains authoritative data for use of those engaged in building and operating public service vehicles. The opening paragraphs refer to an investigation into some failures of aluminium alloy components, the selection of an alloy and the relevant standards. Cast materials and casting processes are discussed and there are notes upon wrought materials in various forms, and both sections are accompanied by a table giving the principal characteristics of the alloys in descending order of merit. The next section briefly reviews workshop practice and deals with machinery riveting, welding, surface finishing, and methods of insulation from other materials. Appendices give in tabular form information concerning mechanical properties, stock sizes and weights, and specific gravities of the alloys.

CEMENTED CARBIDES.—It is announced by Metro-Cutanit, Ltd., of 160, Piccadilly, London, W.1, that its range of "Cutanit" cemented carbides has been extended by the introduction of a new grade, which contains no tungsten carbide, but has chromium carbide as its principal constituent. This material is stated to have high resistance to chemical corrosion, particularly by acids, and good wear resistance, a specific gravity almost half that of normal tungsten carbide grades, and a coefficient of thermal expansion very similar to that of steel. This latter property makes the carbide very suitable for applications in which it is fixed into a steel matrix, either by shrinking or brazing, especially where it is subjected to heat during working. The new material, known as grade "W," is not intended for use as cutting tool tips, and we are informed that a limited number of trial pieces can be supplied through the "Cutanit" distributors, William Jessop and Sons, Ltd., Sheffield.

THE A.D.A. INFORMATION BULLETIN, No. 3.—We have received from the Aluminium Development Association, 33, Grosvenor Street, London, W.1, *Information Bulletin No.* 3 (price 2s.), entitled "The Heat-Treatment and Annealing of Aluminium and its Alloys: Part I, Practice." The *Bulletin* opens with an essential list of what to do and what not to do, and this is followed by tables giving the minimum mechanical properties of work-hardening alloys, heat-treatable wrought alloys, and heat-treatable cast alloys. There are notes upon solution treatment, quenching, natural ageing and precipitation treatment, accompanied by related temperatures and heating periods, and tables dealing with the heat-treatment conditions for aluminium alloys to aircraft specifications. The notes on workshop practice are concerned principally with the control of temperature and time, quality control, degreasing, loading, quenching, refrigerated storage, and stove enamelling temperatures. Brief outlines of the metallurgical principles of age hardening and of annealing are given and illustrated by an equilibrium diagram and curves showing the increase in mechanical properties related to the period of treatment.

Personal and Business

MR. W. LINDSAY BURNS has been appointed chairman of Henry Balfour and Co., Ltd., Leven, Fife.

DR. W. J. WELLWOOD FERGUSON has been elected president of the Illuminating Engineering Society.

MR. J. CASSELS PINKERTON has been elected president of the Royal Institution of Chartered Surveyors.

ALFRED BULLOWS AND SONS, Ltd., Walsall, states that its Glasgow office is now at 70, Gilmour Street, Glasgow, C.5 (telephone, South 2383).

MCGRAW-HILL PUBLISHING COMPANY, Ltd., has moved from Aldwych House, London, W.C.2, to McGraw-Hill House, 95, Farringdon Street, E.C.4 (telephone, Central 0911).

WILLIAM GRAY AND CO., Ltd., announces that Mr. Stephen N. Furness, formerly chairman of the Furness Shipbuilding Company, Ltd., has joined the board of the company.

J. SAMUEL WHITE AND CO., Ltd., states that Sir Charles S. Lillicrap, K.C.B., who retired from the position of Director of Naval Construction last year, has been appointed a director of the company.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., Parnell House, Wilton Road, S.W.1, announces that Mr. F. H. Brooks, general works manager, has been appointed a director of the company.

THE MINISTRY OF CIVIL AVIATION announces the appointment of Mr. Wilfred Gawthorne as civil air adviser to the Commissioner-General, S.E. Asia, and Civil Air Attache, Siam, the Philippines and Vietnam.

MR. ARTHUR HILLIER, chairman and managing director of the Sperry Gyroscope Company, Ltd., has been appointed an Officer de la Legion d'Honneur, in recognition of the contribution he has made to French aviation since the end of the first world war.

BRUCE PEEBLES AND CO., Ltd., Edinburgh, states that Mr. V. P. Mackay has been appointed to the newly created post of chief engineer of the rotating plant department. He will be responsible to Mr. W. B. Laing, joint general manager, for decisions affecting the company's rotating plant business.

British Patent Specifications

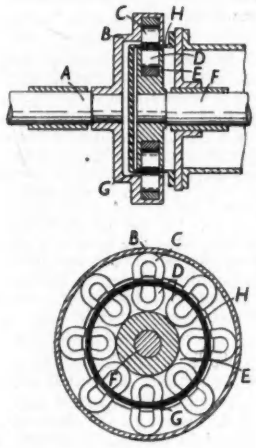
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

ELECTRICAL ENGINEERING

670,682. October 17, 1949.—MAGNETIC COUPLINGS, Geoffrey John Eliot Howard, of 13, Rutland Road, Ellesmere Park, Eccles, Lancashire.

The object of the invention is to provide means for driving a rotary mechanism by means of permanent magnets, the magnetic force operating through a thin sealing member forming part of the enclosure of the mechanism. Referring to the drawing, the driving element *A*, the shaft of an electric motor, carries a non-magnetic housing *B* in which is mounted a ring of permanent magnets

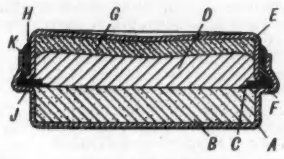


No. 670,682

C of horse-shoe shape. A second ring of permanent magnets *D*, similar in number to the first ring but with their poles facing outwards, is mounted in a housing *E* supported on a shaft *F*, which forms part of the driven element. The two rings of magnets are separated by a gap *G* in which is interposed a sealing member *H*. The magnets in the outer ring may be mounted with adjacent poles of similar or opposite polarity, those on the inner ring being similarly mounted but with the poles the opposite way round, so that a force of attraction will result, the tangential component of this force causing the outer ring to move the inner ring round in step with it. The housing *E* totally encloses the ring of permanent magnets, and as this part of the mechanism may be in contact with the liquid or gas, the housing is made of a suitable corrosive resistance and non-magnetic material. In order to increase the power transmitted, a series of permanent magnets may be stacked alongside one another on both the inner and outer rings. As the pressure inside the sealed part of the mechanism may be considerable and the sealing member *H* has to be thin where it passes through the gap, fluid may be applied to the outside of the sealing member at a pressure equal to that of the fluid pressure inside, thereby avoiding distortion.—*April* 23, 1952.

669,833. December 20, 1948.—ALKALINE ELECTRIC DRY CELLS, Mallory Batteries, Ltd., of Castlereagh Road, Belfast, Northern Ireland.

Referring to the drawings, it will be seen that a shallow cup-shaped cathode container or shell *A* is formed of inert metal, for example, steel. Within it there is compressed cathode-depolariser body *B* comprising an electrically conducting electrolytically-reducible oxygen-yielding compound having a smaller quantity of inert material of higher electrical conductivity admixed with it. The cathode body is a pressed pellet of 95 per cent mercuric oxide and 5 per cent graphite, which is inserted into the cathode container and is consolidated by a high pressure. Upon the upper surface of the cathode body *B* rests an insulating ring or washer *C* of styrene. *D* is a disc or slug of gel having a solution of the alkaline electrolyte dispersed in it. The disc comprises an aqueous alkali metal hydroxide solution, preferably a KOH solution, which is gelled with an alkali metal salt of carboxy-methyl cellulose, such as sodium carboxymethyl cellulose. The anode container *E* is in the form of a shallow cup having an outwardly flaring flange *F* and formed of a metal inert to the electrolyte and having, when amalgamated, a low contact potential to zinc—such as copper, silver-plated copper and silver and alloys. Particularly good results are obtained with anode containers formed of commercial bronze, which is an alloy of 90 per cent copper and 10 per cent zinc. In the anode container there is compressed a body of amalgamated zinc powder *G* constituting the anode of the cell. The electrolyte used for impregnating the zinc powder anode has the same composition as that employed in the preparation of the



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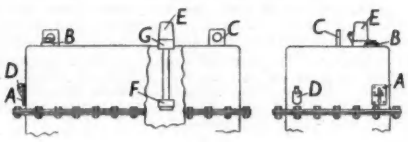
gel disc. In assembling the cell, the gel disc is inserted into the anode container *E* into surface contact with the electrolyte-saturated zinc powder anode *G*. An insulating sealing ring or grommet *H* of polyethylene is stretched around the flared edge of the anode container and is inserted into the open end of the cathode container, resting on the shoulder *J*. The edge *K* of the cathode container is pressed against the circumferential surface of the anode container, forming the crimp seal shown. The grommet *H* is strongly compressed between co-operating portions of the anode and cathode containers and constitutes a substantially fluid-tight enclosure for the cell. The completed cell has an open circuit potential of 1·35V.—*April* 9, 1952.

670,800. July 6, 1949.—LIQUID-COOLED ELECTRICAL APPARATUS, The English Electric Company, Ltd., of Queens House, 28, Kingsway, London, W.C.2. (*Inventor: Hubert Stuart Chirnside.*)

As shown, the transformer or other liquid-cooled apparatus has an enclosing tank provided with an upper flange with a dished cover having a corresponding flange. The flanges are bolted together with a sealing gasket. The cover is provided with a sight glass *A*, a filler plug *B*, and may also be



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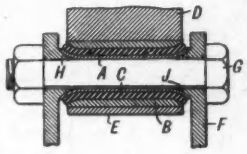
provided with lifting plates *C* and a thermometer pocket *D*. A tap changing switch can be included within the casing and is operated by a handle *E* through a shaft extending through a hollow tube welded to the upper surface of the cover and provided with a sealing gland *F* below the level of oil in the transformer when cold. An additional sealing gland *G* may be included at the upper end of the tube. The construction prevents the possibility of breathing and ensures that any leak which takes place either between the flanges or at the gland, since they are both below the minimum oil level within the transformer casing, will result in oil appearing on the exterior of the transformer and will thus be immediately apparent. Since the gland *F* is on the whole more likely to leak than the seal between the flanges, the additional gland *G* is included in order to minimise the effect of any leak taking place at the first gland.—*April* 23, 1952.

ROAD TRANSPORT

671,811. August 2, 1950.—RESILIENT MOUNTINGS, The General Tire and Rubber Company, of 1708, Englewood Avenue, Akron, Ohio, U.S.A., *assignees of Raymond Hinkley Cowles*, of 192, East Hill Street, Wabash, Indiana, U.S.A.

The invention relates to rubber articulated joints and mountings suitable for use in shackles or spring suspensions of motor vehicles. The joint consists of an inner rigid element or sleeve *A*, an outer rigid element or sleeve *B* concentric with it, and an annulus of rubber *C*, which is maintained by the inner and outer rigid members in a state of relatively high axial elongation and radial compression from its normally moulded state. In accordance with the invention, a major portion of the inner surface of the outer tubular rigid member *B* is cylindrical and the end portions are flared to provide generally frusto-conical portions for contact with a portion of the rubber annulus. As illustrated, the assembled joint is pushed into the eye or ring formed by the frame portion *D* and the loop *E* of the mounted member so that the outer rigid sleeve or tubular



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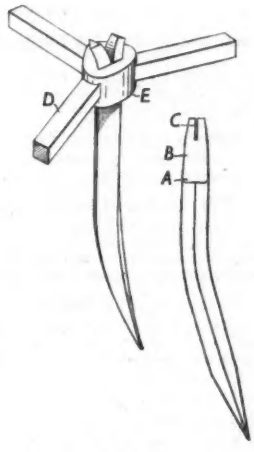
member *B* is rigid with the frame. Means are provided, such as the connecting links *F* and the bolt *G*, for rigidly attaching the undercarriage of a vehicle to the inner rigid member *A*. The links *F* may have, around the portions of the bolt receiving openings, a pintle portion having generally frusto-conical surfaces *H* which are held tightly against the inner surfaces *J* of the inner member.—*May* 14, 1952.

AGRICULTURAL ENGINEERING

672,065. April 5, 1950.—IMPROVEMENTS TO HARROWS, Frederick Walter Choat, Little Corner, York Road, Bury St. Edmunds, Suffolk.

The invention relates to improving and simplifying the mounting of harrow teeth. Referring to the drawings, a harrow tooth is provided with a point at its lower end and is formed, at its upper or root end, with a shoulder *A* and a slightly tapered shank *B*, which is of triangular cross-section and extends beyond the shoulder. Two different tapers are formed on the shank as shown, and it is split axially as at *C* for a short distance downwards from the upper end. At the junction of the cross-members *D* of the harrow frame there is



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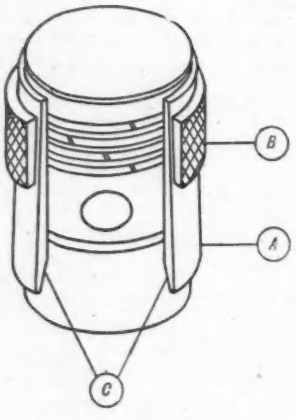
arranged a collar *E* of triangular cross-section; the adjoining ends of the cross-members are welded around the outer face of this collar. The axial aperture through the collar is also of triangular cross-section and fits firmly over the tapered portion of the tooth shank. To attach the tooth to the harrow frame, the shank of the tooth is inserted through the collar from the underside until the shoulder *A* bears against the under-edge of the collar. When so positioned, a chisel is inserted in the slit and the upper tapered portion of the shank is splayed or opened out as shown, so as to hold it firmly against axial displacement in relation to the collar.—*May* 14, 1952.

TOOLS AND WORKSHOP APPLIANCES

672,179. August 12, 1950.—ADJUSTABLE TOOL FOR COMPRESSING PISTON RINGS, William Arthur Jerram, 153, Booth Road, Colindale, London, N.W.9.

The tool comprises two pieces, an inner sleeve *A* and an outer sleeve *B*. Both sleeves have a cut-away gap as shown. The inner sleeve *A* also has one or more vertical slots and is tapered on the outside diameter. The outer sleeve *B* is correspondingly tapered on its inside diameter. The method of adjustment for obtaining various diametrical sizes is by sliding the outer sleeve in a

vertical direction. For obtaining smaller diameters of the inner sleeve the outer sleeve is slid in a vertical direction from top to bottom on the inner sleeve. A chamfer *C* on the inner sleeve facilitates the fitting of the tool over the piston and rings



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when compressing the rings into position on the piston, prior to assembling the piston with rings fitted into the cylinder. The drawing shows the tool fitted to a piston with the rings fully compressed on the piston and in the position for entry into a cylinder.—*May* 14, 1952.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Conference Internationale Des Grands Reseaux Electriques

To-day and Sat., June 6th and 7th.—Fondation Berthelot, 28, Rue Saint Dominique, Paris, fourteenth meeting of the International High Tension Conference.

Institute of British Foundrymen

Tues. to Fri., June 10th to 13th.—Buxton and Sheffield, forty-ninth annual conference.

Institute of Industrial Administration

Wed., June 11th.—LONDON CENTRE: Fyvie Hall, The Polytechnic, Regent Street, W.1, "The Human Factor—The Vitality of Management," "Personnel—A Specialist Function," Anne Shaw, 6.30 p.m.

Institute of Navigation

Fri., June 20th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Dead Reckoning is no Longer the Basis of Navigation," Open Forum, 5 p.m.

Institute of Physics

Tues. to Sat., June 24th to 28th.—Royal Technical College, Glasgow, Fourth Industrial Physics Conference and Exhibition: Physics in the Transport, Shipbuilding and Engineering Industries.

Institute of Road Transport Engineers

Thurs., June 12th.—SCOTTISH CENTRE: Visit to the Works of Polar Engines, Ltd., Govan, Glasgow, 7.15 p.m.

Thurs., June 19th.—Visit to the Peckham Garage of the London Transport Executive, 2 p.m.

Institution of Electrical Engineers

Wed. to Sat., June 25th to 28th.—Summer Meeting in Ireland.

Institution of Production Engineers

Fri., June 13th.—EASTERN COUNTIES SECTION: Garrett Memorial Hall, Ipswich, "Oil for Britain," exhibition by Esso Petroleum Company; "Machine Lubrication," C. J. Taylor, 7.30 p.m.

Wed., June 25th.—EASTERN COUNTIES SECTION: Visit to Suffolk Iron Foundry (1920), Ltd., Stowmarket, 2.30 p.m.

Old Centralians

Fri., June 13th.—Chez Auguste Restaurant, 47, Frith Street, London, W.1, "Engineering Education and Research in U.S.A.," Willis Jackson, 12.55 p.m.

Royal Society

Thurs., June 12th.—The University, Cambridge, "The Origin of the Solar System," H. Jeffreys.

Society of Chemical Industry

Thurs. and Fri., June 12th and 13th.—Connaught Rooms, Queen Street, Kingsway, London, W.C.2, conference on fluidisation technology.

Stephenson Locomotive Society

Sat., June 7th.—Afternoon visits to Brighton locomotive works, Brighton and Redhill running sheds.

Sun., June 15th.—Special Train Tour from Birmingham to Swindon Works, visiting Gloucester and Banbury; hauled by "Saint" class 4–6–0 locomotive.

West of Scotland Iron and Steel Institute

Fri., June 13th.—39, Elmbank Crescent, Glasgow, joint meeting with the British Iron and Steel Research Association, conference on all-basic furnaces, 10 a.m.

Catalogues

TRIER BROTHERS, Ltd., Cumberland Works, Caldew Street, Camberwell, London, S.E.5.—Leaflets describing the Staufferlube Multigreasers.

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Loughborough.—Pamphlet dealing with a 33/38·5kV outdoor oil circuit breaker, type OR.38.

JAMES NEILL AND CO. (SHEFFIELD), Ltd., Composite Steel Works, Napier Street, Sheffield, 11.—Leaflet describing the "Eclipse" Pad Handle.

SANDERSON BROTHERS AND NEWBOULD, Ltd., Attercliffe Steelworks, Sheffield.—Brochure illustrating and describing heliocentric speed reducing gears.

RANSOMES AND RAPIER, Ltd., Waterside Works, Ipswich. Pamphlets dealing with self-priming water pumps, contractors' plant and non-tilting mixers.

WOLSELEY SHEEP SHEARING MACHINE COMPANY, Ltd., Wolseley Works, Electric Avenue, Witton, Birmingham, 6.—Folder giving details of electric fencing.

CHLORIDE BATTERIES, Ltd., Exide Works, Clifton Junction, near Manchester.—Booklet giving examples of the use of battery-powered electric trucks in industry.

ATLAS DIESEL COMPANY, Ltd., Beresford Avenue, Wembley, Middlesex.—Leaflet No. 102, covering a range of pneumatic tools for use in the aircraft industry.

RENOLD AND COVENTRY CHAIN COMPANY, Ltd., Renold Works, Didsbury, Manchester, 20.—Leaflet entitled "Renold Chain Toggle Clutches," Ref. 216/139.

F. PERKINS, Ltd., Peterborough.—Booklet covering the instructions for fitting the Perkins P6V diesel engine in the current Bedford "O" series chassis and also earlier models.

ELECTRICAL REMOTE CONTROL COMPANY, Ltd., 13 and 15, Evanston Avenue, Higham's Park, London, E.4.—Leaflet describing a tilting mercury tube relay capable of operating several tilting mercury tubes.

LAURENCE, SCOTT AND ELECTROMOTORS, Ltd., Manfield House, Southampton Street, Strand, London, W.C.2.—Publication No. 35, describing the "Trislot" high-torque, low-current squirrel-cage motor.

WHARTON CRANE AND HOIST COMPANY, Ltd., Reddich, Stockport.—Sectional catalogue of lifting equipment, including overhead electric travelling cranes, jib cranes, electric chain blocks, pulley blocks, &c.

TANWAY, Ltd., Barnby Dun, Doncaster.—A brochure giving particulars of the types and uses of the firm's centralised lubrication units and a folder with sliding sections showing the method and sequence of operations.

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Publications entitled "Rotary Fine Crusher," "Batch Mixers and Blenders," "Roll Jaw Crushers," "Swing Sledge Mills," and "Ring Roll Mills."

Launches and Trial Trips

DUFFIELD, oil tanker; built by Smith's Dock Company, Ltd., at South Bank-on-Tees, for Hunting and Son, Ltd.; length between perpendiculars 480ft, breadth moulded 67ft, depth moulded 36ft 3in, deadweight 14,500 tons on 28ft 6in draught; service speed 12¼ knots; Hawthorn-Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke, 4450 b.h.p. at 112 r.p.m. Launch, May 23rd.

NORTH KING, oil tanker; built by the Blythswood Shipbuilding Company, Ltd., for the Compania Petrolera De Transportes S.A., of Panama; length between perpendiculars 530ft, breadth moulded 72ft 9in, depth moulded 38ft 8in, deadweight 18,500 tons; Rowan-Doxford oil engine, six cylinders 700mm diameter by 2320mm combined stroke, 7300 b.h.p. Launch, May 26th.

SCOTTISH EAGLE, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the Scottish Tanker Company, Ltd.; length between perpendiculars 515ft, breadth moulded 69ft 6in, depth moulded 38ft 4¼in, deadweight 15,710 tons on 29ft 11in summer draught; twenty-seven cargo oil tanks, two pump rooms, four 500 tons per hour duplex steam pumps; Swan Hunter-Doxford oil engine, six cylinders 670mm diameter by 2320mm combined stroke, 6400 b.h.p. at 115 r.p.m., two oil-fired Scotch boilers, two 150kW diesel generators and one 75kW steam generator, trial speed 14·5 knots. Trial, May 28th.

KARAKOY AND KURUCESME, Bosphorus ferries; built by Chantiers Dubigeon for the Turkish Maritime Authority; length between perpendiculars 52·8m, breadth moulded 13·58m, depth 5m., load draught 2·7m, deadweight 200 tons; eighty-five first-class and 115 second-class passengers; two Sulzer diesel engines, total b.h.p. 1600, speed 13 knots. Trial, May.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

HAND-OPERATED A.C. CIRCUIT BREAKERS FOR AIRCRAFT

No. G.140 : 1952. This specification covers the requirements for hand-operated circuit breakers for use in nominal 200V, three-phase, 400-cycle A.C. systems in aircraft. Price 1s. 6d.

COLOUR CODE FOR TWIN COMPENSATING CABLES FOR THERMO-COUPLES

No. 1843 : 1950. This standard provides for an indication of the nature of the thermo-couple with which the compensating cable is intended to be used and also the polarity of the individual conductor. These compensating cables are a pair of wires having such temperature-E.M.F. characteristics relative to the thermo-couple that, when properly connected to it, the thermo-couple reference junction is in effect extended to the other end of the wires. Price 1s.

METHODS OF TESTING RAW RUBBER AND UNVULCANISED COMPOUNDED RUBBER —PART I, SAMPLING

No. 1673 : 1952. This is a further section of the revision of B.S. 902, "Methods of Testing Latex, Raw Rubber and Unvulcanised Compound Rubber." The standard gives methods of sampling bales of raw rubber and unvulcanised compounded rubber in such a way that the portion which is submitted to the tests will provide test results which will give a reliable indication of the quality of the whole of the rubber which the test portion represents. An appendix is included relating to the assessment of the quality of homogeneous lots of crude rubber by a statistical technique. Price 2s.

COVERED ELECTRODES FOR THE METAL-ARC WELDING OF MILD STEEL

No. 639 : 1952. This standard supersedes the previous edition issued in 1935 and specifies only one class of normal penetration electrode. In line with recent developments, requirements for deep penetration electrodes are included. A comprehensive scheme for testing electrodes is laid down; it involves initial tests to which each type or modified type of electrode is subjected, and periodic check tests which consist of a selection of the initial tests to be repeated at intervals, to prove that the electrodes currently produced continue to possess the properties recorded in the initial tests. For normal penetration electrodes the initial tests are all-weld tensile, all-weld impact, tee joint fillet weld hot cracking, transverse tensile, transverse bend and cruciform fillet weld tensile. The periodic check tests are the all-weld tensile and tee joint fillet weld hot cracking tests. For deep penetration butt welding electrodes the initial and periodic check tests are transverse tensile, transverse bend and butt weld penetration tests. For deep penetration fillet welding electrodes the initial and periodic check tests are cruciform fillet weld tensile and fillet weld penetration tests.

In the foreword it is emphasised that an assessment of the quality of an electrode and its suitability for use on general or particular work cannot be based solely on numerical results obtained from a series of mechanical tests, such as those laid down, but must take into account various other factors which do not readily admit of precise definition. The factors concerned are enumerated. Price 4s.

Codes of Practice

ELECTRIC LIFTS FOR PASSENGERS, GOODS AND SERVICE

Code 407.101. The Council for Codes of Practice for Buildings has now issued in final form "Electric Lifts for Passengers, Goods and Service." It deals with the installation in flats, shops and department stores, hospitals and industrial premises of lifts operated by electric power for passengers, goods and service. It indicates the information which should be exchanged between interested parties and the sequence of events from the inquiry stage to the handing over of the installation. General guidance is given on the conditions which govern the choice of equipment, the location of lifts and machine room, and the service requirements from, and co-operation with, other trades. Structural requirements are also dealt with. The Code carries the usual warning that, in the present abnormal conditions, it may not be practicable to carry out all the recommendations. Copies may be obtained from the British Standards Institution, 24–28, Victoria Street, London, S.W.1, price 4s.